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16. Abstract

This report contains a description of the Service and Methods Demonstration Program. Recently completed and current and future demonstration projects are described and project results from similar demonstrations are compared. The comparisons are made by grouping projects according to the program objectives addressed: (1) decrease transit travel time, (2) increase transit reliability, (3) increase transit coverage, (4) increase transit vehicle productivity, and (5) improve the mobility of transit dependents.

Independent activities carried out in support of the demonstrations are described, such as the development of evaluation guidelines and improved methodologies for demonstration evaluation, analytical studies in support of the development of experimental demonstrations, studies of independent local innovations, and case studies of transit operations in small communities. Information dissemination mechanisms and activities intended to facilitate more widespread knowledge of effective approaches to improving transit are discussed.

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PREFACE

Information exchange on a timely basis is of crucial importance to the Service and Methods Demonstration Program activities. One element in that effort is an annual accounting of the results of the previous years' activities in both sponsoring local innovations in public transportation and monitoring related local initiatives. It is hoped that bringing this together in one annual source document will aid transportation policy formulation at local, State, and Federal levels. This is the second year that an annual report of program activities has been published.

This annual report is developed for the Service and Methods Demonstration (SMD) Program by the Office of Systems Research and Analysis at the Transportation Systems Center. It is prepared in close collaboration with SMD Program staff, various private contractors retained to carry out specific research and evaluation tasks, and local staff directly involved with the innovations being reported. It is important to note that operational demonstration projects represent a cooperative effort in policy research between State, local, and Federal levels of government. At the State and local levels, there are usually several different public agencies involved with the implementation and operation of a demonstration under the leadership of a lead local agency. It is clearly not a unilateral Federal effort, but an effort that depends heavily on State and local initiative. The SMD Program is very appreciative of the many partnerships it has formed with State and local innovators and the courage and competence they are exhibiting in the testing of the many project concepts under consideration in the program. Often there is controversy and political risk associated with these tests until the fears as to what might be an outcome are replaced by actual positive results. Our hope is that these vanguard efforts will benefit all those interested in urban public transportation improvements.

Ronald J. Fisher
Director, Office of Service
and Methods Demonstrations

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EXECUTIVE SUMMARY

The UMTA Service and Methods Demonstration (SMD) Program addresses the national need to improve the quality, quantity, and efficiency of public transportation services by sponsoring the development, demonstration, and evaluation of innovative transit operating techniques and services which utilize existing technology. The SMD Program also has the goals of reducing institutional and regulatory obstacles to improved operations; seeking a more efficient balance of travel demand between modes, times of day, and geographic areas; and improving transportation for the transit dependent.

The basic premise of the Service and Methods Demonstration activity is that much better performance of existing urban transportation systems can be attained through the imaginative use of traffic management, pricing and marketing techniques, transit service variations and state-of-the-art technology. The demonstrations are intended primarily to develop public transportation improvement models and then to bring about their widespread adoption in conjunction with other UMTA efforts and DOT programs. The program has very high payoff potential with respect to efficient improvements in the quality of transit service and is directly supportive of the Transportation Systems Management Element (TSME) of the joint planning and programming regulations issued by UMTA and FHWA. Further, the program supports the major national goals of improved air quality and energy conservation.

The authority to conduct demonstrations to improve transit facilities, equipment, methods and techniques was the first authority granted by Congress in initiating a Federal Government role in mass transportation in 1961. In the early years of the UMTA demonstration program, only limited consideration was given to a coordinated set of program goals and to a structured process of implementation, operation, evaluation, and dissemination. In particular, the lack of consistent procedures for carrying out demonstration evaluations hindered, and in some cases precluded, meaningful comparison of project results or their application to other settings. The lack of widespread knowledge of project findings was indicative of the need for improved information dissemination. In recognition of these deficiencies, the SMD Program was established in FY74 to provide a consistent and comprehensive framework within

which to formulate, implement, evaluate, and disseminate results of demonstrations.

A prime consideration in attempting to increase the effectiveness of the SMD Program has been to identify objectives which would be clearly attainable by virtue of actions taken as part of the demonstrations, independent of exogenous conditions. The following objectives were chosen to categorize projects for program purposes on the basis of their being operational, technically credible, and supportive of the goals cited above.

- Reduce travel time by transit.
  This is an important factor in increasing transit ridership and improving vehicle productivity.

- Increase the area coverage of transit service.
  This is important for increasing transit ridership, yet responding with cost-effective approaches to public pressure for new transit service in our lower density suburban and non-urbanized areas.

- Improve the reliability of transit service.
  This is one of the most important factors in maintaining and increasing ridership.

- Increase the productivity of transit vehicles.
  This is most important in the continuing struggle to reduce operating deficits while maintaining or improving service.

- Improve the mobility of the transit dependent.
  The development of promising techniques to achieve this is necessary to respond to increased pressure to provide mobility to people without automobiles.

DEMONSTRATION ACCOMPLISHMENTS

Reduce Travel Time, Increase Coverage, Improve Reliability

Three of the program objectives, those relating to travel time reductions, increased coverage, and improved reliability, together reflect an attempt to enhance the overall level of transit service available to the public. Thus many of the demonstrations undertaken in the Service and Methods Demonstration Program are aimed at meeting combinations of these objectives.

Reserved Bus and Carpool Lane, I-95, Miami, Florida

Transit improvements which impact these objectives include traffic management techniques, new service concepts, and innovative combinations of existing service concepts.

Traffic management techniques include preferential treatment for high occupancy vehicles (buses and carpools) as well as methods for monitoring and controlling traffic flow on freeways and urban arterial streets. Demonstrations utilizing traffic management techniques have been developed to address the problem of peak hour congestion and people movement in heavily travelled urban corridors. These demonstrations have involved the close cooperation of the FHWA and UMTA at the Federal level; and transit operators, traffic engineers, highway engineers and planners at the local level. Two outstanding experimental successes are now operating completely under local sponsorship: the Shirley Highway Express Bus-On-Freeway Project, Northern Virginia, and the contraflow bus lane approaching the Lincoln Tunnel in Northern New Jersey.

Current projects are confirming that traffic management techniques are effective in reducing transit travel times and attracting riders to express buses and carpools.

In Miami, a two-phase project is testing bus priority strategies on a ten-mile arterial facility and an adjacent freeway. In Phase I, express bus service was established on Miami's N.W. 7th Avenue, and different priority systems were tested in several different combinations of reserved lane and signal preemption. The best operational combination, buses traveling on a reserved reversible median lane with signal preemption, resulted in a 25 percent reduction in travel time, from 24 minutes to 18 minutes.

In Phase II, which began in March 1976, the express bus operation was moved to a pair of newly constructed bus and carpool lanes in the former median strip of I-95. Travel time over this ten-mile segment was further reduced to 12 minutes with an increase in bus patronage.

In Los Angeles, the existing median lanes of the Santa Monica Freeway were reserved for the exclusive use of buses and carpools during peak periods in March 1976. This was the first time an existing freeway lane in the direction of traffic flow had been set aside for high occupancy vehicles without a traffic barrier. Also associated with the project were three park-and-ride lots, ramp metering, and expanded bus service. The demonstration encountered significant public opposition and was discontinued as a result of a court decision that the project required an environmental

impact statement. However, during the 22 weeks of the project's operation, transit ridership tripled, carpools more than doubled, and transit travel times and reliability were signficantly improved. Substantially fewer vehicles were required to transport approximately the same number of travelers that were using the freeway prior to the project. An increased number of accidents was observed and is being further analyzed.

In Houston, a series of Service and Methods Demonstration sponsored corridor improvements are part of a broader transit improvement program which will include new buses, new routes and schedules, a downtown minibus circulation system, and an areawide carpooling program. The demonstration will involve several different freeway bus priority strategies, park-and-ride lots, and possibly ramp metering. These techniques will make it possible to achieve major improvements in transit coverage, reliability, and transit travel times.

Many new and integrated service concepts have been shown to be effective in obtaining substantial improvements in the quality and quantity of areawide transit services. Current demonstrations of areawide services which usually combine paratransit modes with conventional transit servies are being implemented in both small cities and in sections of medium-sized urban areas.

In Rochester, a comprehensive attempt is being made to provide improved transit service in the suburbs through the use of demand-responsive transit integrated with fixed-route service. Though responsive to all of the program's objectives, it is primarily aimed at developing a cost-effective strategy to increase area coverage and reduce trip time. A dial-a-ride operation has been implemented to provide demand-responsive circulation service in suburban areas, as well as feeding and coordinating with fixed-route buses. Subscription buses provide service to employment centers and meet express commuter buses. Significant innovations associated with integrating the services include the balanced provision of fixed-route or demand-responsive service where and when each is most efficient and improved coordination of transfers between these service modes. Although this demonstration has been plagued with major vehicle reliability problems which have impaired the quality of service, new riders and markets have been served.

A noteworthy accomplishment of the Rochester project has been the successful demonstration of the feasibility and utility of a computerized dispatching system. This state-

of-the-art technology should make it possible to increase the productivity and improve the reliability of demand-responsive transportation systems in addition to reducing the onerous waiting times which frequently discourage transit use. Future demonstrations of integrated demand-responsive and fixed-route transit will involve a larger area served by the system and controlled by an automated dispatch system. These areawide systems will provide excellent transit coverage and either demand-responsive or fixed-route service as appropriate.

A major effort is being made to obtain greater participation in the improvement of public transportation by the taxicab industry, which is still largely privately held. The markets available to this industry can be increased through the provision of shared-ride service and other paratransit options to augment its traditional exclusive ride service. Although the institutional barriers to innovation and service integration differ among large and small urban areas, the basic concept of integrating demand-responsive service with fixed-route service is very promising in both environments.

In Xenia, Ohio, a variety of paratransit services are being provided by the local taxi company. In addition to addressing the SMD objectives of improved coverage, reliability, and transit travel time, the project has the local objectives of demonstrating the feasibility of paratransit in a small city and of determining an appropriate role for the private provider in their public transit operations. Interim results suggest substantial reductions in operating costs and ridership growth in response to coverage and reliability improvements.

The transportation broker concept currently under development and demonstration in Knoxville, Tennessee, has special potential for improving transit service coverage and efficiency. The transportation broker matches individual travel desires with existing service and determines the demand for and encourages the efficient supply of new and expanded transit services. In Knoxville, the broker is promoting all forms of ridesharing and transit. Accomplishments to date include establishment of an operational vanpool program using publicly owned vehicles and reduction of legal and regulatory obstacles to ridesharing.

In Westport, Connecticut, the Transit District which presently operates fixed-route services is expanding its role by performing the function of a transportation broker

in a demonstration which will integrate privately operated taxi service with publicly-operated transit and encourage commuter carpooling and vanpooling. Although the integration of these services involves special problems in integrating management, fares, schedules, and transfers, this model may ultimately prove to be one of the most effective and broadly applicable demonstration concepts.

A further attempt to capitalize on the transportation resources of the taxi industry is taking place in St. Bernard Parish, a suburb of New Orleans. This project is one of the first in the U.S. to make use of shared-ride taxicab feeder service to bus routes. A dispatcher will coordinate taxi pickups to reduce travelers' transfer times.

In addition to the projects, the SMD Program is conducting studies which have laid the groundwork for future demonstration projects. A study which has evaluated the auto restricted zone (ARZ) concept and developed preliminary demonstration designs for several cities is nearing completion. Auto restricted zones, areas in which automobile traffic is restricted or prohibited, are expected to lead to improvements in transit service and the urban environment. The SMD Program has worked with the cities of Boston, MA; Burlington, VT; Memphis, TN; Providence, RI; and Tuscon, AR, to develop candidate demonstration designs. A decision on the location and scope of the ARZ demonstrations will be made during FY77.

An evaluative study of transit malls has been recently initiated. Transit malls, a concept closely related to auto restricted zones, are streets closed to all traffic except buses and pedestrians. This study will attempt to assess the operational performance and impacts of transit malls in order to provide guidance for planning and design.

The Service and Methods Demonstration Program is also investigating techniques for improving transit service in suburban locations. One promising concept presently under study is timed transfer focal point service, which involves scheduling buses on intersecting routes to permit convenient transfers with very little or no transfer wait time. In the appropriate settings, this technique can offer large travel time savings to transit users.

Increase Transit Productivity - Service Approaches

Because the subsidies required to provide high quality transit service have been growing rapidly, methods of

Wheelchair Lift on a Bus Serving the Handicapped and Elderly in Portland, Oregon

reducing costs while still maintaining a high level of service are of significant interest to transit operators, users, and taxpayers. Thus, the achievement of improved economic efficiency in the operating and scheduling of transit vehicles, as well as raising the occupancy of all passenger carrying vehicles, is an important part of the program objective of increasing transit vehicle productivity. Important external benefits also come with improved transit vehicle productivity. As more people travel in fewer vehicles, the person-carrying capacity of existing transportation networks is increased with attendant reductions in congestion, energy consumption, accidents, and air pollution.

A wide variety of techniques have been identified for improving the productivity of transit resources. Many of these techniques are also effective in achieving the other SMD objectives of improving transit coverage, travel times, and reliability. Foremost among these are service improvements and new services to attract higher ridership, the concept of transportation brokerage, integration of service types, and more efficient scheduling and dispatching. Other service-oriented techniques for increasing productivity of transit vehicles include subscription service for repetitive trips, shared-ride taxi service, and the utilization of different size vehicles for different service areas and types. More efficient vehicle utilization can also be achieved with improved management and marketing strategies.

Very closely allied with the travel time objective is the effort to raise vehicle productivities through subscription arrangements. In areas where commuter trips cannot be served conveniently or economically by conventional fixed-route transit, subscription service may be utilized to increase vehicle occupancies and decrease the number of single occupant vehicles. In doing so, the service area or outreach of public transportation may be expanded at a minimal cost. Subscription service may be provided by taxi operators, bus operators, and vans driven by commuters either through ad hoc or publicly organized efforts. Demonstrations in Rochester, Knoxville, and Westport contain subscription services as part of an integrated service package. It is estimated that several hundred urban areas are candidates for this type of innovative transit service model.

Two examples of effective subscription commuter services were studied during FY76. The Reston Commuter Bus (RCB) carries persons residing in Reston, Virginia, to

employment areas in and around downtown Washington, D.C. In Southern California, the COM-Bus service links residential and employment areas in the Los Angeles metropolitan area. These projects are not part of the SMD Program and neither receives Federal funds. However, the approaches taken by Reston and COM-Bus may be applicable elsewhere, hence they have been analyzed and documented for dissemination through the SMD Program.

Even greater improvements in subscription bus productivity may be achieved by a strategy which will use coordinated, staggered work hours at a major employment center to permit the subscription vehicle to accomplish multiple runs during the peak hour. A study has indicated the feasibility of this concept in El Segundo, California, and a demonstration design is being developed.

Whereas taxis in conventional operation provide high quality service, they are generally too expensive for most people to use frequently. Shared-ride taxis can provide high quality transportation service at fares considerably lower than conventional taxi fares without adversely affecting the taxi operator's profits. The lower fares enable more people to use taxi service. Ridership growth and shared riding enable the taxi operator to carry more passengers per vehicle-hour at little or no additional cost, thus maintaining or increasing profits. Demonstration projects are being planned in Arlington County, Virginia, and Nassau County, New York, to develop methods to improve the productivity of shared-ride services.

Another straightforward approach for improving transit productivity is the utilization of larger vehicles on bus routes marked by heavy demand. As additional drivers are not required, double deck buses can provide capacity increases with less than proportionate increases in operating costs. On heavily travelled routes this will result in a reduction in operating costs per passenger.

The SMD Program is assessing the operational feasibility of the double deck bus over a range of United States transit service conditions through experience with daily revenue service in two sites. In Los Angeles, two German Neoplan double deck buses with a capacity of 84 seated passengers plus standees have been substituted for conventional (40-50 seat) buses for some of the runs on the San Bernardino Express Busway from El Monte to the Los Angeles CBD.

In New York eight British Leyland buses, with a capacity of 64 seated passengers plus 19 standees, operate over two local Manhattan routes characterized by short trips, crowded vehicles, and heavy traffic congestion.

The double deck buses in both operating environments are expected to improve transit vehicle productivity. Analyses of operating data from both sites will be completed by September 1977.

Increase Transit Productivity - Pricing Strategies

Pricing policies can improve transit productivity and increase the efficiency of transportation systems through the deliberate redirection of travel choices in favor of high occupancy modes. The SMD Transportation Pricing Program is a coordinated series of projects to demonstrate and evaluate the effectiveness of pricing in ameliorating urban transportation problems and achieving related urban goals.

The Transportation Pricing Program consists of three major concept areas; auto user pricing, transit fare policies, and transit fare and related service variations.

Auto user pricing involves the use of disincentives which influence the single driver to switch to a high occupancy mode -- ride-sharing or transit -- and thus make more efficient use of urban transportation facilities. Road pricing policies include congestion pricing, i.e., levying charges on autos using streets in congested zones at congested times, and corridor pricing, where low occupancy vehicles traveling in a corridor or using congested expressways are selectively priced. Parking pricing, or requiring that autos display a purchased sticker when parking in designated areas, is similar to road pricing except that the enforcement measures resemble parking meter enforcement. A variety of reports have been produced which describe the important elements of auto user pricing, including equity and implementation considerations. Feasibility and site selection studies have been conducted, and demonstrations including these techniques are being planned.

Demonstrations have been planned in response to Title II requirements[1] to investigate the issues and potential related to fare-free transit and should provide the basis for making comparisons between fare-free and reduced fare policies. A demonstration of offpeak systemwide fare-free service will be conducted in Mercer Co., New Jersey, and Salt Lake City, Utah. Demonstrations are also being planned to examine the effects of fare elimination in downtown areas. Impacts on transit users, non-users, vehicular and pedestrian traffic, and economic activity will be assessed. During FY76 a study of the different forms of fare prepayment mechanisms that have been used by the transit industry was completed. It describes the most promising fare prepayment practices and indicates possible forms of implementation. Fare prepayment and reduced price promotions will be demonstrated in Phoenix, AZ, and Austin, TX. These demonstrations will assess the potential of discounts, prepaid passes, and promotions in attracting specific market segments to transit and achieving higher levels of ridership and productivity.

A question of key interest to a transit agency involves the tradeoffs between fare reductions and service improvements (reduced travel time, increased frequency, etc.), and which are likely to produce the greatest improvements in transit ridership and productivity at the lowest cost. Using data from a program of service and fare variations conducted by the San Diego Transit System, a study is underway to determine how operating changes of various types have influenced the patronage and operating costs on selected routes. Subsequent to this study, one or more demonstrations will be conducted with controlled service improvements of the type that appear to be most cost-effective in boosting ridership.

A policy oriented mode choice model is being developed for use in forecasting the impact of these fare and service variations. It will be tested using data from the forthcoming fare-free demonstration in Mercer Co., NJ.

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[1]Title II is a provision of the National Mass Transportation Assistance Act of 1974 calling for demonstration projects to determine the feasibility of fare-free transit.

Commuter Vanpooling in Knoxville, Tennessee;
City-Owned Vans are made available through
the Transportation Broker

Improve Mobility for the Transit Dependent

Providing mobility for those who are unable to afford or use an automobile is central to this objective. This constituency includes the young, old, poor, handicapped, and unemployed, and project concepts ought to take into account all such user groups. However, constrained program resources and the intensity of political interest in particular groups combine to confine the focus of this program element at any point in time.

During the period of the civil disorders and rioting in inner city neighborhoods in 1966-67, the limited demonstration resource concentrated on employment facilitation service models, especially service to outlying employment centers. Since the early 1970's, the emphasis of the SMD Program has been on the elderly and handicapped, responsive in particular to Section 16 of the Urban Mass Transportation Act (so-called, Biaggi Amendment, added by PL-91-453 in 1970), which states in part:

> "It is hereby declared to be the national policy that elderly and handicapped persons have the same right as other persons to utilize mass transportation facilities and services; that special efforts shall be made in the planning and design of mass transportation facilities and services so that the availability to elderly and handicapped persons of mass transportation which they can effectively utilize will be assured..."

Recent UMTA regulations call for all transportation improvement programs submitted to UMTA after September 30, 1976, to include projects designed specifically to benefit wheelchair users and those with semi-ambulatory capabilities.

Through a structured series of demonstration projects and studies, the SMD Program has been examining the feasibility and effectiveness of various transportation service concepts in meeting the transportation needs of the elderly and handicapped.

The fundamental demonstration approach to innovation has been to start with a relatively simple application of a service concept and then to modify and expand upon the concept as it is subsequently implemented in different

settings. Within the basic service model of demand-responsive, door-to-door service, there has been extensive variation and experimentation with respect to service area characteristics, deployment of specialized vehicles and other equipment, and policies regarding user eligibility and service availability. Moreover, the demonstrations have been implemented in a diversity of institutional settings, with public or private providers, varying degrees of social service agency participation, and different methods of subsidy.

Demonstrations in Syracuse, New York, Baton Rouge, Louisiana, and Cleveland, Ohio, were completed in FY76 and final evaluation reports are forthcoming. These demonstrations all provided advance reservation demand-responsive service, in some cases supplemented by subscription, group charter, or immediate-request service. Although they differed in terms of fleet size (small for Syracuse and Baton Rouge), service area size and target population density (small area, high density in Cleveland), and eligibility requirements and trip purpose restrictions (medical trips only in Baton Rouge), they all improved the mobility of the target market. Moreover, they provided transferable findings and experience regarding the operation of special services for the elderly and handicapped. For example, the projects have tended to confirm the experience gleaned from general purpose demand-responsive services regarding the sensitivity of service productivity and cost to factors such as service area size, target market density, and specific operational policies. Many of these projects have experimented with innovative techniques to provide specialized service more cost-effectively -- for example, service area segmentation, trip purpose prioritization, and emphasis on advance reservation, rather than immediate request service. It is significant that all three services have continued to operate under other funding sources.

Another group of demonstrations has focused on the development of a community-wide transit service model for cities of successively larger size. Naugatuck Valley, Connecticut, has, since 1972, been the site of a subscription and dial-a-ride service featuring automated credit card billing. The fare collection equipment is activated by a credit card to record time of travel, trip distance, and other information, thereby permitting computerized billing to riders and social service agencies, as well as analyses of travel patterns and vehicle usage. The rider may be billed for a portion of the trip charge with the supporting agency paying the remainder. The Naugatuck Valley service provides 3,000 trips per week, two-

thirds of which are group charter trips. Progress in the area of coordinating social service agency transportation has been facilitated by the credit card billing system.

To test the application of the Naugatuck model in larger cities, the SMD Program is sponsoring a demonstration in Portland, Oregon. This project involves close integration between the specialized demand-responsive and regular fixed-route services, more extensive coordination with social service agencies, and refinement of the fare collection system. In Portland, the public transit authority will operate the specialized service, and major emphasis is being placed on tailoring the service through market research to those unable to use conventional fixed-route transit.

Still another important family of demonstrations is testing the viability and effectiveness of the user-side subsidy concept. Under this type of subsidy mechanism, selected user groups are provided with tokens or transportation vouchers at less than face value which the transportation provider (i.e., private taxi or bus operator) redeems at face value, or even at a premium, from the agency administering the program. The underlying theory is that by directing funds to users rather than to providers of service (as is usually the case), selected user groups can increase their transportation buying power and exercise greater travel choice, stimulating competitive providers to make service improvements or innovations to serve their special needs. With reasonable success, it may be possible with this concept to reduce the impetus toward the institutionalization of public providers to meet the mobility needs of the transit dependent. This concept also has special potential with respect to possible use by clients of HEW programs, using HEW funds to subsidize certain trips, e.g., travel to meal centers under the nutrition support program.

In FY75, a user-side subsidy demonstration was started in Danville, Illinois, a small community (43,000 population) with shared-ride taxi operations. The user-side subsidy concept has proved to be workable from an administrative standpoint. Moreover, taxis have proved to be a viable transit mode, both in terms of cost per trip and level of service. Additional projects are being planned in Lawrence, Massachusetts, and Montgomery, Alabama, which will further explore the feasibility and effectiveness of the user-side subsidy concept in larger settings with fixed-route transit as well as taxi service. The subsidy will enable the user to choose among modes and providers based on cost and level of service differences.

Another innovative service concept being demonstrated in Mountain View, California, involves the use of a community broker, who acts as middleman between specific users desiring transportation services and transportation providers. The broker, by organizing trips to shopping, medical, and recreational destinations on a pre-scheduled, shared-ride basis, provides users with access to more efficient, less expensive transportation than would be possible for individual travelers.

In the various SMD projects funded to date, at least a portion of the fleet has consisted of small vehicles specially equipped to handle wheelchair passengers. In order to examine the feasibility and impacts of deploying specially-equipped vehicles of larger size in fixed-route bus service, the SMD Program is evaluating several projects involving the retrofit of full-size buses to provide level entry and other safety and convenience features. This effort involves locally initiated equipment modifications (San Diego, CA, Atlanta, GA, St. Louis, MO, and Los Angeles, CA, are possible sites) and a demonstration of retrofitted vehicle service. The evaluations will examine the mechanical reliability of the lift devices, effects on transit operations and cost, utilization by wheelchair-confined and semi-ambulatory passengers, and impact on service to the general public.

Concurrent with demonstration activities to develop and evaluate a variety of service concepts for the transit dependent, the SMD Program has sponsored a major study on the transportation problems of the transportation handicapped. The overall objective of this research project is to determine the travel requirements of various classifications of transportation handicapped people and to develop viable transportation service alternatives utilizing all modes which can satisfy such requirements cost-effectively. The study will address the issue of full accessibility of mass transit services vs. specially designed services, and will suggest promising service mixes and concepts. Among the study outputs will be a manual on urban transportation planning for the transportation handicapped and some designs for future SMD projects.

In the coming year the SMD Program will begin to study the mobility problems and travel desires of other classes of transit dependents. A study will be conducted on the transportation needs of the residents of inner cities, where there exist large concentrations not only of elderly and handicapped, but also of poor, young, and unemployed persons. The study will collect data on the travel

requirements of inner city residents, analyze existing transportation deficiencies, and develop alternative service concepts, institutional frameworks, and financial arrangements for meeting these needs. The three most promising alternatives will then be developed into site-specific demonstration project designs for later testing.

DEMONSTRATION EVALUATION

A crucial component of the Service and Methods Demonstration Program is the performance of technically sound and objective evaluations of the demonstration projects. Under UMTA sponsorship, the Transportation Systems Center (TSC) of the U.S. Department of Transportation, has established and conducts a program of demonstration evaluation and supporting evaluation methodology development.

The various demonstrations are intended to serve as either real-world experiments involving innovative service concepts or techniques implemented, or as exemplary models to be applied or adapted by other locales across the country. Accordingly, the focus of the evaluations is threefold: (1) to assess the institutional and operational feasibility of the demonstration concepts and techniques; (2) to assess the transportation and socioeconomic impacts of the demonstration project; and (3) to provide guidance, based on operational experience during the demonstration, for future applications of the concepts and techniques. In addition to their specific utility to the SMD Program, the demonstration evaluations also provide increased knowledge essential for improved urban transportation planning and policy formulation, both at the local and national level.

The SMD Program attempts to maximize the quality and utility of information gained from the demonstrations by developing and employing a consistent, carefully structured approach to a demonstration evaluation. Each evaluation is built around a basic supply-demand analytical framework and utilizes state-of-the-art data collection and analysis techniques which are consistent from the standpoint of efficiency, accuracy, and output. This standardized approach involves a detailed description of the demonstration background, objectives, setting, implementation process, and operations, as well as an analysis of supply and demand changes and the impact of these changes on users, providers, and other groups of interest. This stress on consistency does not, however, preclude recognition of the unique learning potential within each demonstration. Since

Transferring from Fixed-Route Bus to Shared-Ride Taxi,
St. Bernard Parish, Louisiana

demonstrations vary in terms of objectives, relevant issues, complexity content, and context, the scope and emphasis of each evaluation are tailored to the specific characteristics of the demonstration. A variety of reports describing the SMD evaluation process have been published during the past year.

SUPPORT ACTIVITIES

In addition to the efforts described elsewhere in this summary, the SMD Program has sponsored a number of studies and other activities with the dual objectives of supporting various elements of the SMD Program and contributing to the advancement of the state-of-the-art in transit planning and operations. These studies play a pivotal role in the SMD Program activities of concept development and demonstration planning and design. Typically, these studies also result in the generation of new insights and analytical techniques which are useful to transit planners and decision-makers across the nation. Since these studies are of interest to other elements of UMTA and DOT, they are sometimes sponsored jointly.

Small City Transit Program

Last year a program was initiated at the Transportation Systems Center to develop technical information on public transit in small cities to be disseminated to communities between 10,000-50,000 population which are either providing, planning, or considering public transportation. This recently completed program produced a set of reports, which have received widespread distribution. These reports consisted of an overview report, 13 case studies of small city transit experiences, and summary of available state-aid programs for planning and operating public transit. The information gathered in these studies formed the basis for a 1976 TRB Conference Session and six regional Public Transit Seminars for small communities held in Chapel Hill, NC; Evansville, IN; Eugene, OR; Merced, CA; Westport, CT; and Boulder, CO. Attendees included local officials from small cities, state transportation officials, transit operators, planners, and interested citizens. A film illustrating 4 examples of innovative transit services appropriate to small communities was also produced and is being widely distributed by the DOT Public Affairs Office.

Simulation for Traffic Management Analysis

Simulation of the movement of traffic on city streets and expressways is being used to evaluate proposed traffic management and bus priority strategies. Computer model SCOT (Simulation of COrridor Traffic) and its extension STRAP (Simulation of TRaffic Analysis and Planning) were developed to serve as laboratory test beds for the evaluation of candidate traffic control strategies prior to field demonstration.

These simulation models have been used to evaluate the following bus operation strategies: traffic signal preemption by buses in contraflow lanes in downtown Minneapolis; mid-block pedestrian crosswalks and traffic signals; and signal progression timed to bus speeds. Particularly encouraging results have been obtained for bus progressive signals. These results are promising because implementation costs for bus progressive signals are low, simply those incurred in changing the signal timings. If further study confirms that the benefits are as large as those incurred using the much more costly preemption system, an extremely important bus priority strategy will be available to both small and large cities.

Transit Service Reliability Study

This study is investigating the nature and causes of transit service reliability problems, possible improvement strategies, and the potential benefits to travelers and providers of improved service reliability.

The goals of this study include; (1) the fostering of transit reliability improvements through the dissemination of new awareness of the role and importance of transit reliability; (2) the identification and development of improvement strategies that can be demonstrated; and (3) the improvement of the measurement and evaluation of reliability in complex demonstration settings.

Interim findings suggest that transit reliability improvements are likely to benefit transit providers through a reduction in the vehicle-hours and driver-hours required to produce the same amount of service, or through an increase in the amount of service that can be provided with the same expenditure of resources.

Attitudinal Measurement Techniques

An eighteen-month effort is underway to develop improved attitudinal measurement techniques for transportation planning and evaluation. The validity of attitudinal measurement in predicting travel behavior is being examined and potentially useful approaches will be tested in selected SMD demonstrations. Market research tools, survey design considerations, and analytical procedures are being incorporated into a comprehensive manual on attitude measurement which is intended for use by transportation planners and transit operators.

Demand-Responsive Transit Patronage Model

In response to the need for planning methods specifically applicable to demand-responsive transportation (DRT) systems, a study is underway to develop a computer-based procedure intended for use by local planners which will predict DRT patronage.

The patronage forecasting procedure consists of three basic modules: work trip and non-work trip demand models relying on disaggregate choice theory; a level of service prediction capability; and an equilibration procedure which is necessary because the level of service in demand-responsive systems depends on patronage and vice versa. Recognizing that many agencies will not have the staff and resources to implement and use the detailed model, a simplified "sketch planning" model is also being developed.

Shared-Ride Automobile

In order to expand the range of ridesharing options available to commuters, the SMD Program is investigating the feasibility of the shared-ride automobile concept. This approach would use individual commuters and their own vehicles to carry riders for a fare from a specified residential area to a specified employment area and return. Unlike a traditional pooling arrangement, the vehicles would be permitted to pick up any rider desiring to travel in the designated direction. The system would have neither predetermined riders nor departure times. Unlike conventional transit, shared-ride auto would not operate on a fixed schedule, and unlike a jitney-type service, the drivers would not necessarily work full-time.

A study will be conducted to explore the operational feasibility of shared-ride auto. This study will expand the description of the concept to delineate thoroughly all operational facets and legal and institutional issues which may affect implementation of the concept, such as insurance, maintenance standards, passenger and driver security, and service reliability.

Information Dissemination

An extensive effort is being made to disseminate program results to a wide range of audiences including transit planners, operators, and public officials through reports documenting specific projects and concepts, and through extensive publications in the professional literature.

Recognizing that written materials by themselves, are not always the most effective way to disseminate information, the SMD Program has been making use of a variety of other channels and media. As mentioned previously, this has included production of regional seminars and a film on the Small City Transit Program. Aspects of the SMD Program and its findings were presented at 18 conferences in the U.S. during FY76. Additionally, the Transportation Task Force of the Urban Consortium, which is composed of representatives of major urban areas, is given summary reports on SMD findings and assists in the determination of priorities for demonstration project planning. Thus the Task Force serves as a channel for a two-way exchange of information between UMTA and urban officials.

CHAPTER 1

INTRODUCTION

PROGRAM DEFINITION AND PURPOSE

The Service and Methods Demonstration (SMD) Program is intended to improve existing transit operations by sponsoring the implementation of new techniques and services throughout the United States. These innovations, which rely on existing transit technology, are intended to produce short range improvements in the quality and quantity of public transportation. Emphasis is placed on effective methods for providing total coordinated transportation for an entire trip, rather than a particular mode. In most cases this requires a combination of modes, integrated and coordinated to supply a variety of transportation services for a variety of users, trip purposes, and travel patterns.

These efforts are intended primarily to develop public transportation improvements and to encourage their widespread adoption in conjunction with other UMTA and DOT programs. This function supports the Transportation Systems Management Element (TSME) of the joint planning and programming regulations issued by UMTA and FHWA which require that local areas consider techniques such as pricing, traffic management, and paratransit to improve transportation efficiency in the preparation of Transportation Improvement Plans. Some of these techniques have already been proved feasible through SMD demonstrations.

New services and methods which meet the SMD transit improvement objectives will also support such important national objectives as improved environmental quality and energy conservation. These improvements will also have more immediate impacts than activities with a long lead time such as the development of a new technology or the implementation of major new facilities.

Public transportation improvements must address the travel needs of the mobility limited and transit dependent segments of the population. From the beginning, the Service and Methods Program has had a strong interest in transportation for the handicapped and elderly. Several projects have been developed to test or demonstrate techniques for serving these population segments. These projects were intended to publicize and expand the range of

proven methods for providing handicapped and elderly persons with mass transportation services that they can effectively use. In this way, the SMD Program has provided insight on some alternative approaches in support of the national policy that handicapped and elderly persons should have the same right as other persons to utilize mass transportation facilities and services.

The SMD Program incorporates ongoing activities previously classified as Service Development, Urban Corridor, and Intermodal Integration as well as new demonstrations initiated under the SMD label and those in the planning and proposal stages. The current philosophy and structure of the SMD Program are an outgrowth of the experience gained from the demonstrations preceding it.

PROGRAM STRUCTURE

In order to carry out the purposes of the SMD program, a conceptual framework has been established, and from this a functional structure has evolved. Conceptually, the program activities are built around the development of operational techniques for achieving the program objectives. Criteria for project funding and priorities are derived from this and from the relationships between the Office of Service and Methods Demonstrations and other UMTA and DOT administrations. The conceptual framework and functional elements of the SMD Program are described in the following paragraphs.

Program Objectives

The SMD Program has established a series of objectives by which transportation improvements can be judged and which could be attained through demonstrations. The following objectives were initially chosen to categorize projects for program planning purposes:

- Reduce travel time by transit.
  This is an important factor in increasing transit ridership and improving vehicle productivity.

- Increase the area coverage of transit service.
  This is important for increasing transit ridership, yet responding with cost-effective approaches to public pressure for new transit service in lower density suburban and non-urbanized areas.

- Improve the reliability of transit service.
  This is one of the most important factors in maintaining and increasing ridership.

- Increase the productivity of transit vehicles.
  This is most important in the continuing struggle to reduce operating deficits while maintaining or improving service.

- Improve the mobility of transit dependents.
  The development of promising techniques to achieve this is necessary to respond to increased pressure for better mobility among people without automobiles.

These objectives have been used since the beginning of the SMD Program but are subject to replacement or augmentation as other objectives become important to the fulfillment of UMTA's long range transportation goals.

Functional Elements

The SMD Program is divided into four functional elements: concept development, demonstrations, evaluation, and information dissemination. The first element, concept development, deals primarily with the study and development of ideas for improving transit services that are not presently in use in this country or perhaps which have not been carefully assessed even though they may be in use at one or a few sites. Two approaches to concept development are thus taken depending on the situation: (1) case studies have proven to be an effective mechanism for briefly assessing existing applications of new ideas; (2) where no implementation of an idea is found, feasibility studies or theoretical analyses have been used to determine desirability of testing the concept in an actual demonstration. If the concept appears worthy of further consideration, the next step is normally the demonstration stage.

The second element, SMD demonstrations, have two facets. One facet is to encourage the spread of proven innovative transit services and methods by conducting a series of demonstrations in selected locations, thereby increasing exposure to these techniques. The other facet is the demonstration testing of new ideas that appear promising in order to evaluate their effectiveness in actual operating environments. Demonstrations by themselves are of little

value, however, without the other SMD elements of evaluation and information dissemination.

Evaluation, the third element, plays a particularly important role in the demonstrations. Evaluations generally report on the institutional, operational, and economic results of the service or method demonstrated and on the impacts on the users, suppliers, and the general public. It is the evaluation which determines whether the new transit service or method is worthy of promulgation through the SMD Program, whether further testing or replication under different conditions is necessary, or whether the results were sufficiently disappointing as to not warrant promulgation or further study. Guidelines for evaluating SMD projects have been developed to help ensure consistency of evaluations and permit transferability of results to other cities.

The fourth element of the program is information dissemination. Considerable effort has been devoted to developing effective methods of communicating findings of the program so that appropriate applications of new services and methods can be utilized by urban areas with transportation needs. Recognizing that published reports are not always the most effective way to disseminate information, the program has conducted seminars and workshops, participated in transportation conferences, and produced audio-visual material for public distribution. An important mechanism for maintaining communications with urban governments is the Transportation Task Force of the Urban Consortium, which is composed of representatives of major urban areas. The Task Force acts, in part, as a contact for a two-way exchange of information between U.S. DOT and local decision-makers. The Consortium identifies transportation problems and priorities which are communicated to UMTA and others; these are given consideration in project planning and site selection. Information on promising service concepts and techniques developed by the SMD Program are distributed to the Consortium.

Demonstration Criteria and Funding

For demonstrations of proven techniques, criteria for site selection include the potential for continued use at the demonstration site and an achieved level of effectiveness for the site commensureate with the long range operating costs. These demonstrations should have a potential for expansion under local initiative into broad

programs of transit service improvements. In addition, each potential site must demonstrate a desire and capability, both financially and operationally, to continue and expand the service improvement beyond the termination of the demonstration period.

In order to foster these ends, the local area will be expected to contribute financially to the demonstration. Over the demonstration period, the federal contribution will decline and the local funding will increase, until the entire service is fully supported on a local basis. Thus, before a demonstration begins, a federal disengagement strategy and local funding mechanisms will have been defined.

Federal funding sources other than the Service and Methods Program may also be sought for such investments as new vehicles or roadway modifications. Participation by the UMTA Capital Grants program and the Federal Highway Administration will be solicited for these funds. Therefore, the program involves a high degree of cooperation among various offices in UMTA and DOT modal administrations, as well as among the Federal Government, states, and urban areas.

For operational tests of new ideas, since they are more experimental in nature, there is less expectation that any services or methods implemented will be continued beyond the completion of the demonstration. The Federal Government may provide full financing for any or all elements of the demonstration. The only local commitment required may be operational cooperation for the duration of the experiment. Should an experimental demonstration prove particularly useful, however, the locality may independently elect to continue the service or method.

In years prior to the formation of the Service and Methods Demonstration Program, a variety of demonstration projects were conducted. Since the current program philosophy and structure are an outgrowth of the experience gained from the demonstrations preceding it, a review of these earlier demonstration efforts is appropriate. This background should also be useful as an introduction to the current activities and accomplishments during Fiscal 1976 which are reported in the subsequent chapters.

HISTORICAL PERSPECTIVE

The authority to conduct demonstrations to improve facilities, equipment, methods, and techniques was the first authority granted by Congress in initiating a Federal Government role in mass transportation in 1961.

In the early years of the UMTA demonstration program, the emphasis was on implementing a wide variety of demonstration projects. However, only limited consideration was given to project coordination relative to program goals or to a structured process of implementation, operation, evaluation, and dissemination.

Another characteristic of this period was the overemphasis placed on a transit system's breaking even financially: the success of a project was judged heavily on its ability to produce sufficient farebox revenue to meet operating costs. Public tax support of operating costs was not generally accepted at any level of government. The projects operated in an environment of declining transit ridership, little local financial support for transit, and a relatively passive attitude on the part of the federal government. Yet in spite of meager local resources supporting transit, several demonstration services did continue to operate after Federal support was withdrawn.

Despite the ad hoc nature of UMTA's earlier demonstrations, it is important to note that past projects did provide useful experience for developing new transit services. Some examples of these early demonstrations and the lessons learned from them are given below:

- An experiment with subscription, premium fare commuter bus services in Peoria, Illinois, in the mid-sixties was the forerunner of many similar services operating today.

- In some low density areas, demonstrations of conventional fixed-route transit services to suburban employment centers or commuter rail stations were not successful. This led UMTA to support the development of demand-responsive transit services as an approach to serving contemporary land use patterns.

- Express bus services to downtown areas were sufficiently successful in attracting riders such that numerous cities were inspired to implement express commuter services and in several instances

have added bus priority features which have increased the speed and reliability and consequently the attractiveness of such services.

- Park-and-ride demonstrations have also led to many replications elsewhere. Park-and-ride, as a means of extending transit coverage, has subsequently become an important part of the UMTA program and most transit systems around the country.

- A 1965 Central Business District circulation system in Washington, D.C. had a positive impact on traffic congestion and retail sales. It has been copied in several cities even though the low fares normally charged have produced insufficient revenue to cover operating costs.

- Experiments in Boston and Philadelphia during the sixties to test the effect of fare and service changes on ridership indicated a much stronger passenger reaction to good service levels than low fares, particularly during peak periods. In two other projects it was found that long term passes or monthly rates were popular with transit riders. Nevertheless, the transit industry was not enthusiastic about these approaches at the time since it was felt that they would have a negative impact on net revenue. Now, however, fare prepayment is enjoying somewhat of a resurgence as a means of increasing or retaining transit ridership.

More recently, in fact during the past two years, final results were analyzed for several demonstrations begun prior to the establishment of the SMD Program. They can be categorized generally into express bus services, transit dependent services, and other special services, such as low-fare downtown circulation during offpeak hours. Final impacts for these projects are reported in the FY 1975 and 1976 Annual Reports.

Although most of the earlier projects involved some degree of evaluation, the lack of consistent procedures for carrying out the various evaluation activities and the lack of standardized performance measures hindered, and in some cases precluded any useful comparison of results of one project to another or any extrapolation of project results to other interested cities. These projects produced reports which were printed, distributed and placed in the National Technical Information Service (NTIS). But the lack of

widespread knowledge of the results of these projects indicates that the dissemination approaches used were too passive.

In recognition of the deficiencies and problems, the Service and Methods Demonstration Program was established in Fiscal Year 1974 to provide a consistent and comprehensive framework within which to formulate, implement, evaluate, and disseminate results of demonstrations. In addition to increasing the number of demonstration projects and expanding information dissemination, it remains important to continue to explore and develop new concepts which might upgrade transit service and urban mobility.

CONTENT AND STRUCTURE OF THIS REPORT

The succeeding chapters contain a description of all demonstrations and activities being carried out under the SMD program. Results of the demonstrations are summarized and compared to permit an overall understanding of what has been learned about the applicability and effectiveness of various techniques for improving the quality of public transit. Discussions of demonstrations are organized according to the program objectives to which they are related. The techniques used to meet the objectives, such as bus priorities or demand-responsive service, are described prior to discussion of their application within a particular demonstration.

Chapter 2 describes those demonstrations aimed at improving transit service by meeting three service oriented objectives: decreased travel time, increased coverage, and improved reliability. Chapter 3 deals with the objective of increasing the productivity of transit vehicles and describes the various measures of productivity as well as demonstrations aimed at improving productivity. Demonstrations of methods for improving service for the transit dependent, with emphasis on the elderly and handicapped, are described in Chapter 4.

Chapter 5 discusses the philosophy and approach to the evaluation of demonstration projects. Chapter 6 contains a review of the activities of the small community transit program, including the case studies and regional seminars. It includes an overview of the findings on the operating characteristics of selected systems. Chapter 7 discusses a wide variety of analytical studies conducted in support of the program; to aid in demonstration development and to increase the knowledge base. Chapter 8 summarizes the

information dissemination mechanisms used by the program, and includes a list of major products and activities in this area.

The Appendix contains a detailed description of each of the current demonstrations, including those about to begin operation, those currently underway, and those that were completed during FY76. Each demonstration is described separately with the following information provided:

(1) Project Overview
(2) Objectives
(3) Project Description
(4) Project History and Status
(5) Results
(6) Evaluation and Conclusions
(7) References

REFERENCES

1. P. Benjamin, R. Casey, C. Cofield, C. Heaton, D. Kendall, J. Misner, and H. Simkowitz, Service and Methods Demonstration Program Annual Report, Report No. UMTA-MA-06-0049-75-2, November 1975.

CHAPTER 2

DECREASING TRANSIT TRAVEL TIME, INCREASING TRANSIT COVERAGE, AND IMPROVING TRANSIT RELIABILITY

INTRODUCTION

The Service and Methods Demonstration (SMD) Program addresses three objectives which reflect important aspects of the quality of urban transit service as perceived by the user: decreasing transit travel time, increasing transit coverage, and improving transit reliability. This chapter discusses demonstrations and other innovative projects aimed at meeting one or more of these objectives.

TECHNIQUES

A wide variety of techniques are available for improving transit in terms of the objectives identified above. Some of these techniques involve relatively modest changes to existing conventional transit service whereas others represent entirely new service concepts or major changes to existing systems.

Traffic Management techniques which have been demonstrated in Service and Methods Demonstration projects are receiving increasing attention from transit operators and planning agencies. These techniques include preferential treatment for high occupancy vehicles (buses and carpools) and/or the monitoring and control of the traffic stream. A variety of preferential treatment techniques have provided dramatic improvements in transit travel time and reliability. Preferential treatment techniques have also been used in conjunction with other service improvements to extend coverage as well.

Preferential techniques for freeways include:

- exclusive lanes (physically separated)
- reserved lanes (no physical separation)
- contraflow lanes (utilizing a lane of the opposite direction for peak direction flow)
- ramp metering (regulated access with bus and carpool unrestricted entry)

There are also preferential treatment strategies available for buses operating on urban arterial streets rather than freeways. These options include:

- traffic signal pre-emption (allowing oncoming buses to extend green phase or change traffic signal from red to green)
- traffic signal progression (timed for buses)
- preferential turning movements
- reserved lanes
- transit malls

Additionally, the monitoring of traffic conditions and bus flow may permit quick response to special conditions and improve system reliability.

Many new transit service concepts are being tested and demonstrated. A class of techniques referred to as paratransit are primarily oriented toward increasing transit coverage and providing better service in areas which previously had little or no transit service. Paratransit often utilizes smaller vehicles, sometimes privately owned, and lower cost labor. Examples of paratransit include:

- demand-responsive service
- jitneys
- ridesharing (carpooling, vanpooling)

Demand-responsive service embraces a range of public and private transportation services whose schedules or routes can be influenced by the individual traveler. These services can provide shared-occupancy, door-to-door personalized transportation on demand. Specific forms of demand-responsive service include shared taxi, dial-a-bus, and route-deviation bus. Vanpooling, using vans provided by employers or public agencies, can provide an efficient method for ride sharing in which users function as drivers thereby eliminating the labor portion of transit costs. Carpool matching and promotion services can facilitate ride sharing using private vehicles by identifying individuals who have similar travel patterns.

Whereas the basic concepts embodied in other new services are not necessarily novel, innovative applications

and combinations of these services are noteworthy. These techniques include:

- express bus
- park-and-ride
- subscription service

New fixed route, express bus, or subscription services provide a variety of methods for increasing coverage and level of transit service. Park-and-ride improvements provide the opportunity to drive to a place where a public transit vehicle can be boarded, park at that point, and use transit for the remainder of the trip. Often special provisions are made to encourage commuters to park-and-ride, such as special parking lots, reserved space in existing lots, express transit service from the parking lot to the downtown, or low parking charges in the fringe areas. Park-and-ride, often included in corridor preferential treatment strategies, helps to extend coverage of commuter express bus services.

In contrast to new services, modification to existing service can often achieve similar objectives without totally new system implementation.

Other techniques do not represent new or expanded service per se, but rather improved integration and coordination of transportation supply. Integrated transit via coordinated transfers combines various modes into a system which can increase coverage and provide better levels of transit service (travel time and reliability) to many groups. For example, a dispatcher can coordinate the arrivals of dial-a-ride vans and fixed-route buses at transfer points. Shared-ride taxis can be used as feeders to fixed-route buses on the low density portions of a route. Institutional integration of transit modes also permit greater flexibility and responsiveness to temporal system changes.

In addition, coordination of urban transportation services, also called transportation brokerage, can make arrangements for specific travel needs to be served by the most efficient available transportation resources, both privately and publicly operated. These efforts may include social service agency transportation, vanpooling, carpooling, etc. This concept effectively improves system coverage.

Computerized dispatching refers to the use of computer technology for dispatching of vehicles in response to customer demands. Computerized dispatching may have significant effects on reliability of demand-responsive systems.

Finally, many demonstrations include new vehicles and improved marketing to maximize patronage.

DEMONSTRATION PROJECTS

The previous section identified a variety of techniques available for increasing coverage and improving both travel time and reliability. This section contains an overview of the evolution of these techniques has evolved in the Service and Methods Program.

As evidenced by the 1975 Annual Report, in prior years the majority of the demonstrations included some form of preferential treatment for buses and other high occupancy vehicles. The emphasis on bus priority strategies was a reflection of the fact that preferential techniques offered significant potential for reducing peak period commuter travel times and improving the overall level of service for radial corridor service to the downtown area. These techniques are slated for widespread application as part of U.S. DOT's Transit System Management Program; thus the findings from these projects will be useful to many urban areas.

Whereas techniques to improve corridor service still are an important part of the overall SMD program, a wider range of techniques are represented in FY76 SMD projects. The increasing breadth of the SMD program includes techniques to serve the entire urban area, including lower density areas outside major corridors. As a result, this year's projects encompass a variety of paratransit demonstrations including dial-a-ride, integrated transit, and several new concepts, such as, transportation brokerage. Many of these projects include greater roles for the private providers of transportation services.

Table 1 shows the projects included in this report and the techniques being applied in each demonstration. It can be seen that in addition to innovative methods, many of the demonstrations involve an increased level of resources devoted to transit in the corridors or service areas in which they operate. In particular, the introduction of new bus routes and the intensification of marketing efforts are

TABLE 1. SUMMARY OF TECHNIQUES UTILIZED IN CURRENT PROJECTS

TECHNIQUES/SERVICES	PROJECT: Miami	Santa Monica	Houston	Reston	Com Bus	Rochester	Xenia	Knoxville	Westpt.	St. Bernard	Ann Arbor*
Traffic Management											
- Priority Fwy Lane	x	x	x								
- Priority Art. Lane	x										
- Priority Signaliz.	x										
- Monitoring/Ramp Metering		x	x								
Park-and-Ride	x	x	x								
Express Bus	x	x	x	x	x			x			
Subscription Bus				x	x	x	x				
Fixed Route (local)	x	x	x	x	x	x		x	x	x	x
Paratransit											
- Dial-a-bus						x					x
- Shared Taxi							x		x	x	
- Route Deviation						x					
- Jitney							x				
- Carpooling								x	x		
- Vanpooling								x	x		
Intergration/ Coordination											
- FR/DRT Transfers						x				x	x
- Transp. Broker								x	x		
- Computer Dispatch						x					

*non-SMD

common to many of the demonstrations. This is consistent with the philosophy of the SMD program, which is to demonstrate a battery of proven innovative techniques as they would be used and combined in a typical transit operation.

Whereas results are not yet available for some of these projects, a description of each demonstration follows, and subsequent sections discuss the results that are available at the present time. More complete descriptions of each project may be found in the Appendices.

CURRENT PROJECTS

Current projects of the Service and Methods Demonstration Program may be grouped into two major categories: commuter services and areawide service. Demonstrations of commuter services include:

- Santa Monica Freeway Preferential Lane
- Miami I-95/N.W. 7th Avenue Bus/Carpool System
- Houston Corridor Improvements

The Santa Monica, Houston, and Miami projects all involve types of preferential treatment of express commuter transit routes and carpools without physical separation on a heavily traveled freeway. In Houston, priority treatments of various types are being implemented on a number of major freeways. The Miami project includes alternative arterial and freeway priority schemes. Two non-SMD projects, the Reston Commuter Bus Service and COM-Bus, are included in this chapter as examples of other innovative concepts. These systems are interesting in that they are profitable subscription home-to-work services developed at the initiative of the commuters themselves. Table 2a summarizes site and project characteristics for the various commuter bus services.

Demonstrations of areawide transit services include:

- Rochester Integrated Transit
- Xenia Model Transit
- Knoxville Transportation Brokerage System
- Westport Integrated Transit

TABLE 2A. SITE AND DEMONSTRATION PROJECT CHARACTERISTICS-COMMUTER/CORRIDOR SERVICES

	Miami	Santa Monica	Houston	Reston	COM-BUS (non-SMD)
SITE CHARACTERISTICS:					San Fernando Valley, L.A., Orange Co.
Market Area Population (1970) Density (1970)	125 sq. mi. 385,000 3,080 persons/mi.^{2}	100 sq. mi. 616,000** 6,200 persons/mi.^{2}**		11.5 mi.^{2} 25,500** 2,217 persons/mi.^{2}**	3,700 to 7600 persons/mi.^{2}
Median Income (1970) Average Auto Ownership	$9,600 1.5 cars/household	$12,400 (mean) 1.4 cars/household		$17,100* 1.6 cars/household	11,000 (mean) 1.3 cars/household
Pre-Demo. Transit Mode Split (Work Trips)	2%	5%			
PROJECT CHARACTERISTICS:					
Traffic Management	reversible, reserved arterial lane with signal progression and/or pre-emption; reserved freeway lane on I-95 for buses and carpools (10 mile corridor)	reserved freeway lane on I-10 for buses and carpools; ramp metering in both directions for entire length (13 mile corridor)	contraflow lane on North Freeway and exclusive or reserved lane on Kathy Freeway; possible preferential ramp strategies on Southwest Freeway; for buses and carpools	existing preferential freeway lane and access ramp utilized	
New Services	park-and-ride; express bus service from outer suburbs to Central Miami including local collection	park-and-ride; express bus service; new suburban local routes	planned park-and-ride in North and Southwest Corridors; new CBD-oriented express bus service	home to work subscription express bus from Reston to D.C. area employment centers; includes local collection and coordinated transfer	home to work subscription express bus from various residential areas to employment centers
Modification to Existing Services	expansion, re-routing, re-scheduling of express bus services; new buses	existing local bus service was re-routed to the freeway	re-routing; re-scheduling; fare changes; new buses		

*1970 figures - pop. 8,300.
**1975 figures

TABLE 2B. SITE AND DEMONSTRATION PROJECT CHARACTERISTICS - AREAWIDE SERVICES

	Rochester (Greece)	Xenia	Knoxville	Westpoint	St. Bernard Parish	Ann Arbor (non-SMD)
SITE CHARACTERISTICS:						
Type of Area	suburb of medium sized city	small city	metro area	suburban town	suburban town in metro area	small city
Service Area	15.3 mi.^{2}	9 mi.^{2}	1350 mi.^{2} (SMSA)*	22 mi.^{2}	8.5 mi.^{2}	21.8 mi.^{2}
Population (1970)	70,000	28,000	400,337	28,000	51,185	110,000
Density (1970)	4150 persons/mi.^{2}	3100 persons/mi.^{2}	296 persons mi.^{2}	1300 persons/mi.^{2}	6016 persons/mi.^{2}	5,040 persons/mi.^{2}
Median Income (1970)	$13,600 (mean)	$10,825 (mean)	$8,236	$21,000	$9,646 (mean)	$12,820
Average Auto Ownership	1.3 cars/household	–	1.3 cars/household	2+ cars	1.4 cars/household	1.2 cars/household
% Elderly	8%	5%	9%	8%	–	5%
PROJECT CHARACTERISTICS:						
New Services	integrated dial-a ride/fixed route bus, advanced reservation or immediate service; home-school/work subscription service; route deviation; handicapped service	jitney tried and discontinued; exclusive & shared-ride taxi; advance request handicapped service; subscription service	transportation broker; express bus; feeder taxi; vanpools; carpool matching	transportation broker; shared-ride taxi; package delivery service; subscription service; car/vanpool marketing/matching service	shared-ride taxi feeder services to fixed route; joint fares for transfer passengers	intergrated dial-a-ride/fixed route bus, advance reservation or immediate service; handicapped & school subscription service
Modification to Existing Services	expanded service area; route rationalization; fares vary by service, user type; group fares	re-routing and re-scheduling after emergency service ended; variable pricing for a mix of services; pre-paid passes; numerous modifications		expanded commuter fixed route service (temporal & spatial); new fare structure	route rationalization; fare changes; expanded fleets; construct shelters	re-routing; re-scheduling; fare changes; 100% coverage

* Efforts have concentrated on the SMSA; however the service area actually includes the entire Eastern Tennessee area (6716 square miles).

TABLE 2B. (CONTINUED)

	Rochester (Greece)	Xenia	Knoxville	Westpoint	St. Bernard Parish	Ann Arbor (non-SMD)
Special Vehicles	minibuses; some lift equipped	new taxis; mini-buses, one lift-equipped	vans for lease to vanpoolers	new vans, mini-buses and coaches	new taxis	dial-a-ride vans; lift-equipped vans
Control/Coordination	fully automated dispatching; digital communications to buses; coordinated transfers			coordinated manual dispatching of public/private providers		computer-assisted central dispatching; coordinated transfers

• St. Bernard Parish Feeder to Bus Service

In addition, the Ann Arbor Teltran system, a non-SMD project, has been included in the chapter. Table 2b summarizes site and project characteristics of areawide services.

These demonstrations include a broad range of improvements in which paratransit modes are utilized, usually in combination with fixed-route conventional transit, to provide a complete areawide high quality transit service. The current applications of areawide integrated transit range from small cities to sections of medium-sized urban areas. The Ann Arbor and Rochester systems are similar in concept--the integration of fixed-route and dial-a-ride services to provide 100 percent coverage. The other projects include taxi-based and auto-based modes of paratransit, thus emphasizing privately-owned modes of transportation.

The various SMD projects are in different phases of implementation. Interim results are available for the Miami, Santa Monica, Rochester, Xenia, and Knoxville projects. Houston, Westport, and St. Bernard Parish are new projects that have not yet been implemented. Tables 3a through 3c summarize results for those projects already implemented. Summary descriptions of the individual projects are provided below.

Miami I-95/N.W. 7th Avenue Bus/Carpool System

The Miami I-95/N.W. 7th Avenue bus/carpool system (Appendix A) is testing various priority strategies for improving peak period commuter service. These schemes include reserved lanes (without physical barriers) and signal progression and pre-emption.

This demonstration addresses all three serviced-related SMD objectives of this chapter with particular emphasis on travel time and reliability. Coverage is increased by collection tours performed by express buses and park-and-ride facilities (900-1300 parking spaces).

There are two phases of the project: Phase I is the implementation and evaluation of bus priority methods on the major artery in the corridor, N.W. 7th Avenue.

Strategies tested in Phase I included:

Bus Priority Treatment Enabling Buses to Preempt Traffic Signals; Miami, Florida

Stage 0	No priority; buses operating in mixed traffic
Stage 1	Traffic signal pre-emption by buses in mixed traffic
Stage 2	Reversible reserved bus lane and signal pre-emption
Stage 3	Reversible reserved bus lane and signal progression
Stage 4	Reversible reserved bus lane and signal progression and pre-emption

Phase II, which began on March 15, 1976, involves the implementation of an additional median lane in each direction for buses or carpools of three or more persons on the parallel freeway I-95 and transfer of express bus service to the new facility. Special entry ramps from the park-and-ride facility were to have been completed in December 1976.

The following results may be reported for the two phases:

Phase I (N.W. 7th Avenue)

Transit Travel Time -- Bus priority measures were generally effective in reducing bus travel times (Stages 0-2). The degree of improvement was most apparent during the most heavily congested times. Travel times over the priority segment were reduced by 30% between the base case (stage 0) and the reserved lane/pre-emption case.

When the pre-emption capability was deleted and replaced by progression (Stage 3), bus travel times and speeds did not deteriorate; in fact, in some cases they improved. This is attributed to the added incentive to maintain progression speed when pre-emption capability is not available.

When pre-emption equipment was reconnected in addition to progression (Stage 4), travel times improved further.

Transit Reliability -- On the average, transit reliability, expressed as the percent of buses running late, improved by over 60% with the combination of reserved lane and signal pre-emption.

Auto Travel Time -- Average auto travel times along N.W. 7th Avenue in the direction of peak flow for the a.m. peak period were improved during all operational stages, particularly with reserved lane and progression strategies (23% reduction in travel time). Intersection delays, particularly on cross streets, along N.W. 7th Avenue showed some increases. It is difficult to isolate the impact of the project from the effects of increased traffic, although it appears that pre-emption contributed to these delays.

Transit Ridership -- During Phase I, express bus ridership grew by 37% on N.W. 7th Avenue routes compared to 15% on routes elsewhere in the city. Bus trips represented 6.6-8.3% of arterial trips during a.m. peak hours. Transit mode split increased from 5.1% before the project to 17.5% during Phase I (based on Orange Streaker routes only and total person trips in defined market). The project attracted many new riders: 52% of bus riders previously drove alone, 14% had not made the trip previously, and 73% were choice riders.

Coverage -- Only 16% of the bus riders used feeder access; 54% used park-and-ride; 23% kiss-and-ride.

System Performance -- Person trips on N.W. 7th Avenue increased by as much as 40% when express bus service was implemented. Buses represented 2% of the total vehicles and carried 22-29% of the total a.m. peak direction person trips on the arterial. Auto use would have required a 30% increase in vehicles to accommodate the trips.

Accidents -- During Stage 2 (reserved lane and pre-emption) there was, on the average, one transit accident every 4.5 days, or 280 accidents per million bus miles (compared to a national average for city buses of one transit accident every 55.5 days). Many of these accidents resulted from illegal left turns made by autos.

Phase II (I-95 Freeway) Preliminary Results

Transit Travel Time -- After a month of I-95 operation, a time savings of approximately five minutes enabled adjustment of bus schedules.

Transit Ridership -- Bus ridership increased 9.3% during the first 3-1/2 months of Phase II. Buses carried approximately 9% of a.m. peak direction person-trips on I-95.

Carpool Ridership -- Average vehicle occupancy increased from 1.20 to 1.34 persons per car.

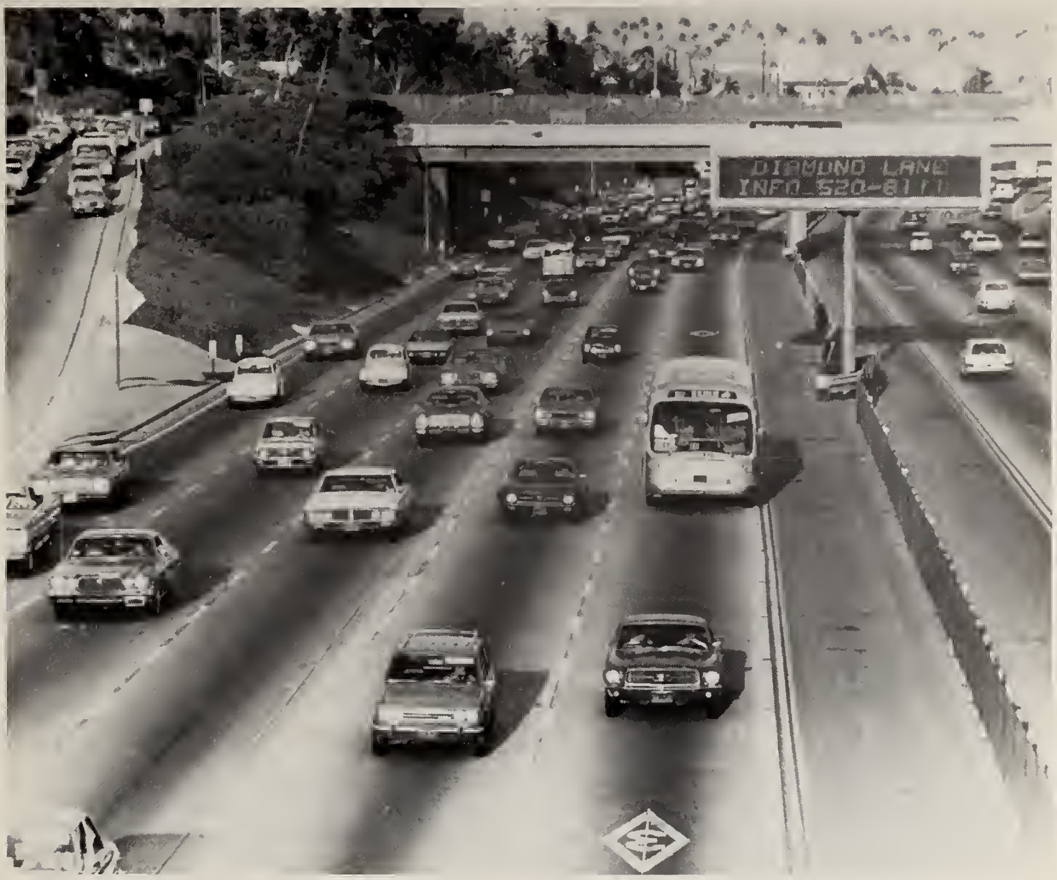
Violations -- About 40% of the vehicles in the exclusive lane were violators.

Accidents -- A serious problem has been the elimination of median shoulders and grass medians due to construction of the exclusive lanes. This has left no refuge area for breakdowns and has resulted in a number of accidents. These accidents, particularly four fatalities, have generated a strong negative reaction in the media. Improved signing and paving markings have reduced accidents but have not eliminated the problem with breakdowns. Florida's DOT is presently considering providing a freeway patrol to remove disabled vehicles or closing the lane during offpeak hours.

Santa Monica Freeway Preferential Lane Demonstration

The Santa Monica project (Appendix B) was aimed at increasing use of transit and carpools in order to increase freeway capacity, reduce energy consumption, and improve air quality. It consisted of reserving the center lanes in each direction of the Santa Monica Freeway for the exclusive use of buses and carpools. The lanes operated during peak hours without any barriers. It was the first time such a project had been initiated by taking a busy freeway lane out of existing service. The eight to twelve-lane Santa Monica Freeway is equipped with metered on-ramps with preferential entry provisions at selected locations, a computerized surveillance system, and centrally controlled electronic displays. Seven new express bus services, including three serving new park-and-ride lots (total of 720 spaces), were introduced with the project to increase coverage. In addition, four express bus routes in operation on the freeway prior to project implementation were able to take advantage of the preferential lane.

The application of the reserved freeway lane bus and carpool priority concept on the Santa Monica Freeway was a response to two major characteristics of the area:



Santa Monica Freeway "Diamond Lane" Bus and Carpool Lane in Operation

- serious air pollution from auto emissions,

- an extensive and heavily traveled freeway system.

The demonstration resulted in significant public opposition and has been discontinued due to a court ruling that an environmental impact statement was required. However, during the 21 weeks of operation, data were collected and some preliminary results of the demonstration evaluation can be reported:

Transit Coverage and Service Frequency. The addition of new express bus service more than doubled the number of Westside CBD workers living within walking distance of express bus service. On the first day of the project, a total of 74 express bus runs were made from the Westside area to the Los Angeles CBD during the morning peak, an increase of more than four times pre-project levels.

Transit Travel Time -- The new express bus services brought about significant reductions in average transit travel times. New bus routes brought about savings in CBD travel times of up to 25 percent of pre-project levels. Express bus routes in existence prior to the demonstration realized travel time savings of roughly two minutes per trip.

Transit Reliability -- The lanes improved transit reliability as well. Before the experiment, 32% of a.m. peak buses and 65% of p.m. peak buses were late. In contrast, during the project 23% of the a.m. buses and 35% of the p.m. buses were late.

Transit Ridership -- Average daily transit ridership more than tripled during the course of the project and reached a level of 3% of all freeway users during project hours . Nearly 95% of all bus riders reported some degree of satisfaction with the service.

Non-User Travel Time -- Although freeway travel times for non-carpoolers improved throughout the project, travel times never reached pre-project levels. Automobiles traveling over the 12.5 mile length of the project in the non-preferential lanes averaged 20 minutes for the inbound morning trip and 22 minutes for the outbound trip during the evening peak. Comparable travel times prior to the project were 16 mintues and 18 minutes, respectively. At certain on-ramps, moreover, waiting times increased during the project,

adding to the total trip delays experienced by non-carpoolers.

Carpool Ridership -- Free assistance in forming carpools was offered by a local non-profit organization. In addition, private companies developed experimental vanpool programs offering complete free use of vans to those who volunteered to drive. Three-or-more person carpools increased from 2% of all vehicles to over 5% of all vehicles by the end of the project (or increased from 5.4% to over 15% of person-trips). The average vehicle occupancy rate on the freeway rose from 1.23 before implementation to 1.36 by the end of the project.

Freeway Performance -- The operation of the lanes on opening day created a number of serious problems, including extreme congestion, meter malfunctions, and an excessive number of accidents. By the second day, however, performance had improved dramatically. During the last seven weeks of operation, the average number of person-trips carried in the peak directions during the hours of preferential lane operation was 69,353, 99.5% of the pre-project total. These trips were carried by 50,644 vehicles, 86% of the pre-project total.

Accidents -- Accidents increased from an average of 10 per week before the project to 59 during the first week. Accidents later stabilized at about 25 per week for the last 16 weeks of the project. The increased rate of accidents is of primary concern and is being further analyzed.

Violations and Enforcement -- Violations decreased over the course of the project to approximately 8% of vehicles in the reserved lanes and police deployment was gradually reduced to the pre-implementation level midway through the project demonstration. Even after deployment levels returned to normal, the number of tickets issued on the freeway during project operating hours was approximately triple pre-project levels.

Public Response -- A telephone information center set up in cooperation with the mayor's office provided a forum for the expression of public opinion. During the first few weeks of operation there was overwhelming opposition to the project, but as the operation progressed fewer calls were received and more of the comments were positive. The local news media were

decidedly against the project and public opposition persisted up until the court ruling. Surveys revealed overwhelming public opposition to the project, as well as public animosity toward the California Department of Transportation for continuing the project in the face of perceived congestion, increased accidents, and public outcry.

On the positive side, the Santa Monica Freeway Preferential Lane project succeeded in attracting riders to carpools and transit, and appeared to be headed toward increasing freeway capacity without requiring additional levels of police deployment. However, the project brought about a significant increase in freeway accidents, and occasioned a heated public outcry which continued to threaten the implementation of other preferential treatment projects in Southern California.

Certain types of preferential treatment projects have been shown to be successful elsewhere in improving carpool and bus ridership. When preferential lanes are not separated from the general flow of traffic, however, frequent shifts between lanes operating at markedly different speeds can lead to accident increases. The problem of accidents in barrier-free operation is a serious one, and requires further investigation.

The Santa Monica Freeway project marks the first time a preferential lane project has been initiated by taking a busy freeway lane out of existing service and dedicating it to the exclusive use of high-occupancy vehicles. Other preferential lane projects have constructed additional preferential lanes or utilized lanes in non-peak directions. The initial confusion and congestion resulting from the denial of a lane to traffic, coupled with the higher accident levels and the perceived emptiness of the lane when compared with the remaining lanes, help to explain the widespread opposition to the project. Other factors explaining the intensity of opposition to the project may include the great dependence on the automobile in a higher income, sprawling area. Similar reactions might be expected in areas with similar characteristics.

Houston Corridor Improvement Demonstration

Houston, presently the fastest growing city in the United States and fifth most populous is, unlike many cities, experiencing CBD growth. Eighty-five percent of Houston's commuters drive to work alone, resulting in

TABLE 3A. PROJECT RESULTS FOR COMMUTER/CORRIDOR SERVICES - PREFERENTIAL TREATMENT

		MIAMI							SANTA MONICA	
		Phase I: NW 7th Avenue					Phase II: I-95			
	Stage:	0	1	2	3	4	Before	After	Before	After
Travel Time:										
• Average transit travel time (min.)	AM:	26.3	21.2	18.5	n.a.	n.a.	n.a.		42*	32*
	PM:	29.8	21.9	20.4	n.a.	n.a.				
• Average transit speed (mph)	AM:	23.0	28.0	32.0	n.a.	n.a.	n.a.		n.a.	n.a.
	PM:	20.0	27.0	29.0	n.a.	n.a.				
• Average carpool travel time (min.)		-	-	-	-	-	n.a.		n.a.	14
• Average carpool speed (mph)		-	-	-			n.a.		n.a.	55
• Average auto travel time (min)										
- freeway time only	AM:	27.3	25.0	24.1	20.6	21.7	n.a.		n.a.	20
	PM:	29.9	25.7	26.9	24.0	26.3				
- ramp delay (unweighted average)		-	-	-	-	-	n.a.		4.7	3.3
									AM (inbound)	
									4.0	6.8
									PM (outbound)	
• Average freeway auto speed (mph)	AM:	22.0	24.0	25.0	29.0	27.0	n.a.		n.a.	39
	PM:	20.0	23.0	22.0	25.0	23.0				
Reliability:										
• Transit time variability (standard deviation/mean)	PM:	.10	n.a.	n.a.	.096	.08	n.a.		n.a.	
• % of buses late	PM:	25%	n.a.	n.a.	13%	9%	n.a.		AM: 31%	23%
									PM: 65%	35%

*Maximum reduction: Average savings of 5 minutes on other routes.

- = not applicable
n.a. = not applicable

TABLE 3A. (CONTINUED)

	MIAMI				SANTA MONICA	
	Phase I: NW 7th Avenue		Phase II: I-95			
	Before	After	Before	After	Before	After
Coverage:						
• No. of new routes	n.a.	1	-	1	-	11
• No. of bus trips or facility (runs/day)	0	45	18	55	35	182
• No. of park & ride spaces avail.	0	950	0	950-1300	90	720
• No. of park & ride spaces untilized	-	450	-	n.a.	-	100-200
Ridership:						
• Transit ridership (pass.-trips/day)	1150	1700	1150	1700	1260	3850
• Transit-mode share (peak hours)	6%	17%	n.a.	n.a.	1%	3%
• Carpool mode share	-	-	2%	10% AM (inbound)	2%	5%
• Automobile occupancy	n.a.	n.a.	1.20	1.34 AM (inbound)	1.20	1.35
Safety:						
• Accident rate (no. per week)	n.a.	1	n.a.	n.a.	10	20

- = not applicable
n.a. = not applicable

significant congestion and deterioration of air quality. The Service and Methods demonstration of corridor improvements (Appendix C) is one element of a program of transportation improvements in Houston which includes revitalization of the city's bus fleet, improvements in routes and schedules, implementation of a downtown minibus circulation system, and initiation of an areawide carpooling program. These improvements are all aimed at reducing vehicle-miles traveled to comply with EPA directives. The SMD project specifically addresses all three SMD service objectives, as well as additional local objectives to encourage the acceptance and use of public transportation.

Planned project improvements include additional CBD-oriented express service with park-and-ride lots. The North Freeway corridor is the proposed site of a contraflow lane for priority treatment. In the Southwest Corridor preferential freeway entry for buses may be considered; non-priority ramp signals were recently installed by the State Department of Highways and Public Transportation. Katy Freeway improvements are still in the planning stages.

None of the SMD improvements has yet been implemented in Houston due to a number of factors, including inability to locate land for park-and-ride lots. A study has recently indicated that costs will greatly exceed those originally estimated and that the construction and operation of the North Freeway improvements alone would exceed the total project budget. Due to interference from other construction, however, improvements in a fourth corridor have been cancelled and a recent reallocation of funds has been made.

Reston Commuter Bus Service

The Reston Commuter Bus (RCB) Service (Appendix J) is a community-initiated service operating between Reston, Virginia, and major employment centers in the District of Columbia. The service is not part of the UMTA SMD program and receives no Federal funds. Since the approach taken in Reston may be applicable elsewhere, it is being analyzed and documented for dissemination to other communities through the SMD program.

The Reston service is relevant to the SMD objectives of reducing travel time and increasing transit coverage. RCB is a non-profit organization; it is neither a transit authority or common carrier. It owns no buses but instead contracts with public or private carriers. RCB has been

both a client and competitor to the Washington Metropolitan Area Transit Authority (WMATA). Nationwide precedents have been set by legal decisions with regard to institutional and regulatory issues. Unique aspects of RCB service are the level of citizen participation and the financial viability of the operation.

Planned as a "new town," Reston is a suburban community with high median income and educational levels, and a high degree of citizen involvement in community affairs. A high proportion of Federal government workers live in Reston and commute to downtown Washington and nearby Virginia employment centers.

The RCB commuter buses travel from Reston to Washington, D.C. after circulating through the Reston community to pick up passengers. These buses converge on a fixed schedule at a special freeway access ramp (closed to autos) where transfers are made. Buses continue on the freeway to various employment centers. Similarly, on the return trip transfers are made before the express line-haul portion. A straggler bus is provided after the p.m. peak period to enhance the evening service.

The collection system has enabled 92% of the system users to access the bus by walking. Routes within Reston change frequently in response to demand. Riders pay in advance for the service and new routes are not added until existing patronage warrants their introduction.

RCB service is presently provided by a private carrier who utilizes part-time, non-union labor. (A previous contract with WMATA was cancelled.) Volunteer "busmeisters" perform fare collection and record-keeping functions as well as liaison between passengers and drivers or administration. Busmeisters ride the service free.

The RCB operation has achieved increases in coverage and experienced reductions in travel time. These results are summarized below (and shown in Table 3-b):

<u>Transit Travel Time</u> -- The RCB now averages approximately 60 minutes travel time compared to 50-60 minutes for the comparable auto trip.

<u>Transit Coverage</u> -- Whereas the previous service operated on main streets only with each bus proceeding directly to Washington destinations on a rigid fixed-route system, the RCB has an extensive collection system and is responsive to changing demands. The

convenience of the service rather than cost advantage is thought to be the major factor in decisions to use the system. It is also worth noting that Reston's location and configuration may have played an important role in bus use. The city is isolated and housing is grouped in clusters. In addition, RCB buses have special access to the Dulles Airport access road, a direct freeway route to Washington operated by the Federal Aviation Administration, which is denied to Reston citizens commuting by auto.

Transit Ridership -- Ridership has grown dramatically since 1968 when it was 1,000 per month to 50,000 now.

In summary, the Reston Commuter Bus experience has demonstrated the feasibility of a community effort to contract for needed express bus service for work trips and maintain a self-supporting operation. It has also shown that a significant number of commuters can be attracted to a high quality, high priced service if it is designed to meet their needs.

COM-Bus

COM-Bus (Appendix K) is a subsidiary of the Southern California Commuter Bus Service, Inc., a privately-owned, profit-oriented, non-subsidized commuter bus system operating in the Los Angeles, California, metropolitan area. Although no federal funds are utilized and the project is not part of the UMTA SMD program, it is included in this report since similar systems might be applicable elsewhere.

COM-Bus supplements public transit service provided by two transit districts. COM-Bus serves commuter trips to employment centers which would otherwise require many transfers and long travel times. The service grew out of a particular need created by the relocation of a major employer. Users are atypical of most transit operations--predominantly male, white collar, and employed as professionals. Nearly all COM-Bus riders previously drove their own cars to work.

Among the issues of interest in this operation are the institutional and regulatory barriers to the system's development, the profit orientation of the service, and the operational procedures. Legal challenges were voiced concerning the right to duplicate routes served by the Transit District and attempts to sever relations with carriers providing "inadequate services." Service

TABLE 3-8. PROJECT RESULTS FOR COMMUTER/CORRIDOR SERVICES - SUBSCRIPTION BUS

	Reston	Los Angeles COMBUS
Travel Time		
• Average Transit Time Time	60 minutes	30-75 minutes varies by route
• Average Auto Time	50-60 minutes	Competitive
• Average Transfer Time	1-6 minutes	No transfers
Coverage		
• No. of Bus Trips (1-way)	36 AM runs/day 34 PM runs/day	47 round trips runs/day
• Collection Coverage	100% in Reston	n.a.
• Access	92% walk 6% park & ride 2% kiss & ride	Most park & ride or kiss & ride
• Destinations Served	3 routes in downtown DC and 4 non-CBD employment centers	12 employment centers
Ridership	50,000/month	42,000/month

n.a. = not available

deterioration encountered with carriers resulted from the fact that their operations tended to be only marginally profitable. At the present time the system is managed by a small, part-time staff. Fare collection, passenger surveys, and route and schedule adherence fall under the administrative functions of bus "captains" and "route coordinators." Persons performing these duties are compensated by free bus service. Other users pay for service on a weekly subscription basis. Fares vary with distances and are in the $13.75 to $15.50 range per week.

Most users drive or are driven to pick-up points (located near residences or at convenient transfer locations) and are dropped off at employment centers. The majority of the routes utilize the San Diego Freeway in the Los Angeles area, which presently has no preferential treatment provisions. New routes are implemented only after adequate demand has been demonstrated. Marketing is carried out where services are not yet offered, however, expansion is not a priority issue.

Buses and professional drivers are obtained on a per-route basis under contracts with local charter bus companies. Southern California Commuter Bus Services, Inc., owns four buses which are leased to COM-Bus and eight minibuses which accept overflow patronage or permit continuation of low patronage services.

The COM-Bus service has successfully extended coverage at travel times which are competitive with the auto. In addition, the use of minibuses to complement regular buses has enabled COM-Bus to improve vehicle productivity. Travel times and productivity have benefited from expansion as more specialized routes with less extensive collection and distribution portions have developed. Ridership (see Table 3b) grew rapidly during the system's first five years, but since 1973, ridership has been stable largely because of the desire to keep the operation at a manageable size.

The system's profitability may be largely attributed to:

- Rider subscription on a weekly basis
- Use of riders for clerical (bus captain) functions
- Ability to contract with charter bus operators and avoid fixed costs of vehicles and facilities.

Rochester Integrated Transit Service Demonstration

The Rochester Integrated Transit Service Demonstration (Appendix D) is a comprehensive project to demonstrate the integrated operation of fixed-route with demand-responsive and other "personalized" bus services, to provide improved transit services. Service related objectives of the demonstration include increasing coverage and level of service and facilitating transfers between different elements of the system.

Significant integration innovations include route rationalization (i.e., providing fixed-route or demand-responsive service where and when each is most effective and efficient) and transfer coordination between demand-responsive and fixed-route services. Special pre-arranged subscription and group services are available for workers, school children, elderly, and handicapped residents. Computerized scheduling and dispatching with digital communications equipment are being tested to determine their impact on service levels and productivities.

Rochester, the home of a number of large corporations, is a city of 300,000 in an urban area of 600,000. At the present time Personal Transit (PERT) service is offered in the suburbs of Greece and Irondequoit. PERT service in Greece includes dial-a-ride integrated with fixed-route service and subscription, charter service for senior citizens, and handicapped services. There are fare reductions for the elderly and handicapped users, for all midday users, and for additional passengers per pick-up. Computer scheduling and dispatching began in September 1975.

Irondequoit PERT service, which was introduced in April 1976, includes integrated fixed-route and dial-a-ride service, route deviation service, a circulation loop bus, and special subscription service.

A major redesign of the services offered in Greece was planned for September 1976 in order to re-establish fixed-route service along major demand corridors. Also, service and fares will be modified to vary with zonal areas, type of service, and type of passenger.

Evaluation of these concepts has been complicated by frequent vehicle failures, especially during winter months, and some communications equipment failures. As a result, negative impacts on level of service have occurred, especially for transferring passengers.

PERT Dial-A-Bus Providing Door-to-Door Service, Rochester, New York

Severe vehicle breakdown problems have plagued the system in general and have impacted ridership, travel times, and reliability. The following results from operations in Greece should therefore be viewed in the appropriate light:

- <u>Transit Travel Time</u> -- Service checks in 1975 during a period of fairly uniform vehicle supply gave the following:

  1. Average response times for immediate requests - 25 minutes

  2. Average ride times - 15 minutes

  3. Average speed aboard dial-a-ride - 11.3 mph

  Measurements at a transfer point in late 1975 and May 1976 revealed that average transfer times to fixed-route vehicles were about seven minutes and to dial-a-ride vehicles about 13-16 minutes.

- <u>Transit Reliability</u> -- The 1975 service checks revealed the following statistics regarding reliability:

  1. Average lateness in pick-up - 6-8 minutes

  2. Standard deviation of lateness - 12 minutes

  One-third of the users surveyed reported late pick-up, most over 10 minutes late (despite user underestimation of actual wait time). The standard deviation of the transfer times between dial-a-ride and fixed-route were approximately 70 to 80 percent of the mean. Attitudinal surveys showed that users rated dial-a-ride service as favorable except in the area of "promptness of pickup" (wait time), where 11% rated the service as "poor" or "very poor."

  The lack of vehicle reliability, especially during the winter months, has been a very serious problem since 1975 and numerous customer complaints, no-shows, and cancellations have resulted, as well as a decline in ridership.

- <u>Transit Coverage</u> -- PERT has provided 100 percent coverage whereas previously only about half the service area population had access to bus service. Special direct services are now available to

shopping and employment centers and for the elderly and handicapped to social service agencies.

Considerable dissatisfaction and ridership loss resulted from a test of route rationalization or the replacement of offpeak fixed-route service with dial-a-ride service requiring transfers. Most former fixed-route users judged fixed-route to be more reliable, convenient, and faster than PERT. Since the original PERT fares were higher than the previous fixed-route fares, offpeak PERT fares were reduced to help mitigate dissatisfaction.

- Transit Ridership -- Dial-a-bus ridership grew from about 175 per day to about 500 per day during the period of March to December 1975 before serious reliability problems developed. Between January and June 1976, ridership has been about 380 per day. A considerable portion of dial-a-bus ridership are transit-dependent, i.e., having no alternative means of travel (1/3 of weekday riders surveyed).

  Home-to-work subscription service has been able to attract, at higher fares, even those who have fixed-route alternatives as well as a significant number of auto users (55% of riders). Ridership during the winter averaged 150-175 passengers per day.

Evaluation of Irondequoit services for an operating period of five months has just begun. During the first twelve weeks ridership has been fairly steady although dial-a-bus service did undergo a growth stage. Route deviation options have so far been under-utilized.

In conclusion, ridership in Rochester has grown in spite of system reliability problems. Some of the innovations have been less successful than others. Route rationalization in Greece and the replacement of a segment of a fixed-route with dial-a-bus service was viewed unfavorably by many users. Dial-A-Ride services, as part of an areawide transit system, have been able to attract and serve new riders and special markets.

Xenia Model Transit Service Demonstration

The Xenia project (Appendix F) is an example of a new system in a small city which previously had no transit service. After a number of modifications, the present system consists of paratransit services operated by the local taxi company. The services offered include exclusive and shared-ride taxis utilizing 7-passenger sedans, advance request dial-a-ride for the handicapped with specially equipped vehicles, and pre-arranged group trips and subscription services utilizing minibuses or sedans.

The project addresses all three SMD service objectives as well as two local objectives:

- to demonstrate the feasibility of paratransit service in a small city;
- to determine an appropriate role for the private sector in public transit operations.

Other innovations that have been included as part of the demonstration include pre-paid passes and a mix of paratransit services with corresponding pricing structures. (The pricing structure has not yet been implemented.)

The setting and history of the Xenia project are somewhat unique. Fare-free, fixed-route service was originally begun under Federal Disaster Assistance Administration Funding in 1974 after a tornado struck and destroyed 52% of the business, 39% of the homes, and 60% of all automobiles and school buses in Xenia. SMD Funding began in mid-1974 and resulted in the use of new small buses, a $0.25 fare, and later, handicapped and Sunday and holiday dial-a-ride services. Plans for expansion and the purchase of new sedan vehicles for complementary dial-a-ride services proceeded. In November 1975, voters turned down a tax proposal to support the fixed-route service and the service was consequently dropped. An unscheduled jitney service during the peak and dial-a-ride in the offpeak were instituted as a temporary measure. These services were modified as control was transferred to the taxi company; later in May 1976, dial-a-ride completely replaced jitney.

Ridership declined from 28,000 per month in the last month of fixed-route operations to an average of 9,400 per month during the months of the city-operated peak period jitney and midday dial-a-ride service (January and February 1976). The ridership decline was not entirely due to the service change; the $0.50 jitney fare was twice that of the

previous fixed-route operation and it had been announced at one point that transit service would end completely at the end of December.

In March 1976, the City contracted with the local taxi company to operate the jitney and demand-responsive service. The terms of the agreement resulted in the jitney frequency being cut by 50 percent and driver compensation being so low that there were insufficient drivers. Consequently, ridership further declined from the January-February level to an average of 6,300 during March and April.

The replacement of peak period jitney service by dial-a-ride in May 1976 and an increase in driver compensation dramatically improved the transit reliability so that by the time the new taxi vehicles were introduced in July, ridership was increasing and had reached nearly 7,400 passengers per month. Continued improvement in service quality and the implementation of all the paratransit services has continued the ridership growth. Approximately 11,200 passengers used the system in September.

The ratio of operating cost to revenues has shown continual improvement since the change from fixed-route to paratransit service. Monthly subsidies and operating ratios for the period of service development described above are as follows:

Service Period	Monthly Subsidy	(Cost/Revenue) Operating Ratio
City Operated Fixed Route Service (last 4 months)	$21,000	8.0
City Operated Jitney Service	14,200	5.2
Privately Operated Jitney Service	9,700	3.6
Taxi Operated Paratransit Service (current service)	8,900	2.7

As the ridership of the paratransit service continues to grow, further reductions in the operating ratio can be expected.

Interim findings with regard to coverage and reliability indicate that:

- Transit coverage has increased as the demand-reponsive service provides more nearly a door-to-

Small Bus in Fixed-Route Bus Service on the X-Line in Xenia, Ohio

Flexicab Taxi Service, Xenia, Ohio

door service for all residents, whereas the former fixed-route and jitney systems served primarily those within easy walking distance of the routes.

- Previous service changes resulting in real or perceived changes in system reliability had corresponding effects on system usage.

Knoxville Brokerage System Demonstration

The Knoxville Transportation Brokerage System Demonstration Project (Appendix G) seeks to establish and institutionalize a mechanism for coordinating a wide range of public and private transportation modes into an efficient, integrated regional network. The function of the transportation broker includes the matching of user desires with the existing services offered by various operators, determination of the demand for and encouraging the development of new services, and acting as ombudsman. The broker will work with social service agencies, taxi, and private bus operators to maximize the efficiency of existing transportation resources. All forms of ridesharing will be promoted by identifying and matching transportation supply and demand, by acting to reduce legal and regulatory restrictions limiting the growth of ridersharing, and by providing advice and information for those interested in ridesharing modes. One component of this project is the establishment of an areawide vanpooling program begun and promoted through the leasing of city-owned vans to groups of commuter with compatible travel patterns outside the transit service area.

Initial efforts have concentrated on serving commuters with vanpools and an express bus service utilizing publicly-owned vehicles. Efforts to relax regulations governing operation of vanpools and carpools have already been successful with only minor inspections, insurance questions, and safety equipment standards remaining. Surveys of employees and social service agencies and the formation of vanpools is proceeding. Experience during the initial stages of the project has indicated that:

- Formation of vanpools requires detailed attention by the broker; more than simply providing information to the individual.

- Significant efforts and time are necessary to achieve institutional and regulatory changes,

including the removal of common carrier classification.

Westport Integrated Transit Services Demonstration Project

In Westport, Connecticut, a demonstration project (Appendix H) has been designed to provide integrated transit service by expanding the role of the Transit District (currently operating fixed-route services). The Transit District in this project will perform the functions of a transportation broker. It will contract with local taxi operators for shared-ride and special market demand-responsive service, as well as operating fixed-route and special market subscription services and providing assistance in the formation of carpools and vanpools.

This project is aimed at expanding transit coverage in a low density area using an appropriate mix of transit and paratransit services. Local objectives include reducing automobile traffic in congested areas.

Westport, an upper middle class community of 28,000 people and 22 square miles, is on the outer rim of the New York Metropolitan area. Many residents commute to work in New York. Bus service was initiated by the community-supported Westport Transit District in 1974. Daytime service includes seven fixed-route loops with a timed transfer at a common central transfer point. A minibus can be hailed anywhere along the route, there being designated system of bus stops. In early morning and late afternoon hours these vehicles operate commuter routes serving the rail stations.

Annual passes for unlimited trips and special discounts are available. The existing system has reached capacity and the demonstration will increase the transit supply and expand temporal and spatial elements of service.

Among the innovations to be undertaken are:

- increased commuter fixed-route service;
- an integrated taxi service offering shared-ride and small package delivery;
- advanced request demand-responsive service for special groups such as the elderly, handicapped, and social service agency clients;

- the implementation of a single control center to dispatch and monitor all transportation services;
- an expanded transportation broker role for the Transit District including development of pooling programs and occasional private providers of paratransit;
- new vehicles including vans, minibuses and coaches;
- a new fare structure; and
- a taxi profit incentive plan to encourage increased productivity.

The Transit District is currently conducting negotiations for a service contract with taxi companies in Westport. Shared-taxi service is scheduled to begin in 1977.

St. Bernard Taxicab Feeder to the Bus Services

This project (Appendix I) is one of the first in the U.S. to involve shared-ride taxicab feeder services to bus routes. The demonstration is aimed at increasing transit coverage in a low density area. A local objective is the development of a viable feeder service which will require little or no subsidy after the demonstration.

St. Bernard Parish (population 60,000) is a suburban area of New Orleans. In 1973, after a previous bus operator went out of business, owners of the taxi company formed the present bus company in the belief that taxi usage was adversely affected by the termination of bus service. In order to cut bus operating costs, a money losing route was modified in 1974 and joint fare shared-ride taxi feeder service was instituted along a portion of both bus routes. Ridership increased and the pilot operation was deemed successful, thus leading to the present expansion plans.

A phased demonstration plan calls for expanding bus and taxi fleets, introducing shared-ride taxi in other service areas with systemwide fare increases, constructing bus shelters and initiating a combination of shared-ride taxi and bus services for commuters on a subscription basis. A dispatcher will coordinate taxi pick-ups to minimize passenger transfer time to regularly scheduled buses. Inbound trips will be arranged by telephone requests,

outbound trips through the fixed-route bus driver. Taxi drivers will receive part of the joint fare which is based on the total trip length.

The demonstration began in mid-1976. No results are available at this time.

Ann Arbor Teltran System

The Ann Arbor, Michigan, system (Appendix E) is a local and state funded project. Because it is an important operating example of integrated fixed-route and demand-responsive transit, it has been documented by the SMD Program.

The basic concept of Teltran is that of an integrated transit, utilizing doorstep dial-a-ride in conjunction with conventional fixed-route service and providing for coordinated free transfers between the two modes. The design of the system reflects two major local objectives: providng 100 percent (door-to-door) coverage; and reducing and maintaining automobile ownership at the one car per family level.

Other major elements of this project are:

1. zone based dial-a-ride service;

2. a computer-aided reservation system; and

3. phased implementation program and development of local public support.

Ann Arbor is a city of 100,000 located just outside the Detroit Metropolitan Area and is the site of the main campus of the University of Michigan. A pilot dial-a-ride project was developed and implemented under State of Michigan demonstration funding in September 1971. In 1973, a 2.5 mil property tax for Teltran was passed in a voter referendum with 61% of the vote and a phased implementation program began soon after. As of July 1976, all daytime dial-a-ride zones had received service.

During daytime hours, the present system consists of a dial-a-ride service in 14 zones or service sectors with coordinated transfers to fixed-route buses operating on five routes. Dial-a-ride vehicles perform flexibly-routed tours with pre-scheduled arrival times at one or two fixed transfer points within each sector, usually located at

existing activity centers. Fixed-route and dial-a-ride vehicles are timed to meet; each waits for the other to arrive. Evening and weekend service is provided predominantly by city-wide dial-a-ride system operating in six or seven sectors with limited fixed-route and route deviation service.

In addition to free transfers, fare reductions are offered for elderly, handicapped, and low income users; monthly passes are available.

The fleet of 32 transit buses and 48 dial-a-ride vans is controlled by three dispatchers utilizing a computer information system, but assigning vehicles to tours manually. A varying number of call-takers log in telephoned requests for immediate, future, or "standing order" (regularly scheduled) service.

Some of the results of the Teltran operation are summarized below:

- <u>Transit Travel Time</u> -- Average response time (time from end of call to pick-up) for immediate service calls averaged 22.9 minutes with a standard deviation of 12.5 minutes. The perceived response times reported by customers were lower, possibly due to effective use of in-home wait time.

  In-vehicle time of daytime dial-a-ride averaged 9.9 minutes with a standard deviation of 6.6. Average in-vehicle distance was 2.3 miles and effective travel speed aboard dial-a-ride was 14.6 mph.

  The average transfer time from dial-a-ride to fixed-route was 6.5 minutes excluding 36% of the riders who had no transfer wait time. Transfers from fixed-route to dial-a-ride service often involve no wait time since vans generally arrive at transfer points prior to fixed-route buses.

- <u>Transit Reliability</u> -- Fifty-nine percent of all customers surveyed reported that vans arrived within the estimated time of arrival periods given by the call taker. These windows vary from five to fifteen minutes in length.

- <u>Telephone Service</u> -- Problems of telephone delays have been overcome with 95% of calls being

Fixed-Route and Dial-A-Ride Van at a Transfer Point
in Ann Arbor, Michigan

TABLE 3C. PROJECT RESULTS FOR AREAWIDE SERVICES - INTEGRATED TRANSIT

	Ann Arbor	Rochester (Greece)[1]
Travel Time:		
• Average ride time aboard DAR	10 minutes (day) 14 minutes (evening)	15 minutes
• Average response time to immediate requests:	23 minutes	25 minutes
• Average speed aboard DAR	14 mph	11 mph
• Average transfer time:		
- to fixed route	4.1 minutes	7 minutes
- to dial-a-ride	0-5 minutes	13-16 minutes
Reliability:		
• Standard deviation of response time to immediate requests	13 minutes	15 minutes
• Lateness:		
- Average	11.5 minutes	6.8 minutes
- Standard deviation	9.8 minutes	12 minutes
• Perceived reliability:		
- % on time	59%	n.a.
- % early	10%	
- % late	31%	
Coverage:		
• Before implementation	n.a.	48%
• After implementation	100%	100%
• No. of Transfers:		
- % no transfer	32%	70%
- % 1 transfer	52%	30%
- % 2+ transfers	16%	
Ridership: (pass-trips/day)		
• Dial-a-ride	3000	390
• Home-Work Subscription	-	100-175
• Feeder Subscription	(incl. in Dial-a-ride)	5-15
• School Subscription	300	80
• Fixed Route	4200	n.a.

	Ann Arbor	Rochester (Greece)
Productivity:		
• DAR vehicle productivity	6.1 (revenue) pax/veh./hour 8.0 total pax/veh/hour	5 pax/veh.-hour

Note: Travel time, reliability and transfer data based on surveys of advanced request and immediate service users, unless otherwise noted.

n.a. - not available - = not applicable

[1] Rochester data was taken before automated dispatching became fully operational.

answered within three minutes and processed within 2.5 minutes.

- Ridership -- Ridership for fiscal year 1975-1976 was projected to be 1.7 million compared to 535,000 on the 1972 fixed-route system. Many new riders were attracted to the service. A survey of daytime riders when the system was only partially implemented revealed that 17% would have driven alone if the service were not available.

Phased implementation has allowed modifications to take place with a minimum of resistance. As the system has stabilized, however, the AATA is responding to user desires for a greater understanding of the system. Although further changes are inevitable, the feasibility of 100 percent coverage and the ability to develop public support and ridership has been demonstrated.

IMPLICATIONS OF RESULTS

Reserved Bus Lanes on Freeways

Previous demonstration projects have shown exclusive and reserved lanes and ramp metering with bypasses for high occupancy vehicles to be effective in reducing travel times and attracting riders to express buses and carpools. Current projects are confirming this and providing additional experience regarding specific approaches.

Reserved lanes in recent projects show 20-25% reductions in transit travel time and improved reliability. Increased use of buses by former auto commuters and additional carpooling has resulted in approximately the same number of person trips carried with over 10 percent fewer vehicles.

Freeway accident rates have increased with installation of no-barrier reserved lanes. This appears to be due to vehicles weaving through traffic to enter and leave the reserved lane and the difference in speed between vehicles in the reserved lane and the adjacent lane. Also, in Miami where a median shoulder was removed to add a reserved lane, the loss of a breakdown lane has contributed further to the accident rate. Maintaining safety with no-barrier reserved lanes remains a serious problem. Accident data is being studied further and techniques to alleviate the problem are being examined.

Where a reserved lane was obtained by the removal of an existing lane on a busy freeway, public opposition was intense enough to cause discontinuation of the project. The most serious inconvenience here was apparently the time delay at entry ramps due to long queues. Opposition was centered around the unfairness of this approach to auto commuting in a very auto-oriented Los Angeles corridor.

Signalization and Traffic Management on Arterials

Signal preemption for buses in mixed traffic has reduced transit travel time. Providing signal preemption together with a reserved arterial bus lane permitted further reductions--up to 30 percent time savings. Signal progression timed to bus speeds with buses operating in a reserved lane provided approximately the same reduction in travel time. Combined preemption and progression appears to further increase average bus speed. The progression-reserved lane strategy caused the greatest improvement in auto flow on parallel lanes in the peak direction.

Substantial improvements in reliability were achieved by these techniques. Many auto drivers have switched to transit as reflected in a ridership growth of 37% on routes benefiting from these priority strategies. Consequently, arterial person trips were increased by up to 40 percent. A 30 percent increase in autos would be necessary to accommodate these trips without the express bus service.

Problems with these strategies include delays experienced by autos in cross-traffic and an increase in transit vehicle accidents. Many of these accidents were caused by autos making illegal left turns and interfering with the oncoming buses.

Subscription Bus Service for Commuters

Recent examination of private sector subscription bus services produced the following insights:

- Coverage can be tailored and adjusted to reflect changes in peak period travel demand patterns. Both bus feeders and park-and-ride are effective, depending upon dispersion or origins.
- Travel time for these bus services is competitive with the auto.

- High quality, reliable work trip transit can be established with the interest and participation of the commuters and employers. Regulatory barriers are likely where the service is provided by the private sector, even where equivalent public bus routes do not exist. These barriers were overcome in the examples studied.

- Subscription bus service can be provided at fare levels such that costs are covered by revenues. Both of the operations studied are experiencing steady increases in ridership.

Integration of Demand-Responsive and Fixed-Route Service

Increased coverage is created by providing connections between dial-a-ride and fixed-route transit. The 100 percent coverage provided by dial-a-ride in suburban service areas can be expanded to other parts of the region, as coordinated access to fixed-routes is introduced.

The coordination of dial-a-ride and fixed-route service has achieved 100 percent coverage at attractive levels of service. The unique characteristics of door-to-door demand-responsive and high productivity fixed-route service have been successfully combined and have attracted new riders. Whereas the concept of integrated transit is clearly promising, system designs are still undergoing changes. Regarding the role of each mode in a coordinated system, there is some indication that the level of service is higher when the dial-a-ride portion of the trip is short and a transfer to fixed-route is possible for longer distances.

Transfer coordination has worked better when both fixed-route and dial-a-ride vehicles are scheduled to arrive at transfer points, rather than having the dial-a-ride vehicles rendezvous only on demand. The latter approach resulted in considerably longer transfer times when transferring from fixed-route to dial-a-ride rather than vice versa.

Route rationalization, that is, the replacement of low demand density portions of fixed-routes with demand-responsive service, may result in a decrease in the level of service for a substantial portion of the affected fixed-route riders. Those living within a short walk of the bus route may find demand-responsive service less desirable because of increased wait time and less direct service. In the instances studied, passengers were dissatisfied by the

higher fares, longer travel times, and reduced reliability that resulted from route rationalization. Unless the perceived level of service is maintained, these disbenefits may outweigh potential advantages of increased coverage and cost reductions, especially where the bulk of the affected passengers are captive riders living near the discontinued portion of the route.

Varying the type of service offered by time of day is beneficial to system productivity and level of service, yet these factors must be traded-off with the complexity of such systems. Experience has shown that users desire basic knowledge about system operation if it is to be considered reliable. Frequent changes in routes, transfer points, service areas, etc., confuse passengers. In Ann Arbor, for example, plans for different mid-day offpeak zones were cancelled due to expected confusion. Reliability of dial-a-ride service is of particular importance since these services are by nature more variable and may be less understandable to users.

Computerized Dispatching of Dial-A-Ride Vehicles

It is too early to draw conclusions regarding the effect of computerized dispatching on personnel requirements, service reliability, and response time (from request to pick-up). However, it appears that more uniform service times and increased capacity (especially important during periods of high call density) of the system are possible with computer dispatching combined with digital communication to vehicles. This automated capability is not necessary in areas that can be easily served by a manual dispatcher and is most helpful in the complex environment of more than one dial-a-ride service zone and coordinated transfers with fixed-route buses.

FUTURE DEMONSTRATIONS

In addition to the ongoing demonstrations, the Service and Methods Demonstration Program is preparing plans for demonstrations that will be carried out in the future. A number of studies are being conducted on innovative concepts for improving transit service. These studies normally consist of an examination of any prior experience with the concept and an analysis of the operational, economic, and institutional feasibility of the concept. Frequently, these studies also include the preliminary design of experimental demonstrations in selected sites.

Waterborne Transit

Ferry systems at one time provided a considerable degree of service in many cities but most were phased out due to competiticn from automobiles and bridge construction. In recent years, however, the amount of congestion on urban highways has suggested a second look at the potential of waterborne transit. With the use of modern, high speed boats, trip times on the water can compete with automobile trip times, particularly during peak periods. In some cases it may be possible to serve areas that are not readily accessible by land transit. Moreover, the boats can be used to give access to recreational areas in offpeak periods and weekends.

A demonstration of waterborne transit will seek to use waterways to supplement urban transit using existing boats such as hovercraft and hydrofoils. The initial demonstration will be conducted in a city with existing ferry operations in order to take advantage of its experience in conducting marine passenger services. The demonstration will determine consumer acceptance of the service, economics of operations, reliability of existing boats, user response to various fare levels, and changes in boat design needed to make the craft more acceptable for commuter operations. New York City has been selected for the initial demonstration; if it is operationally successful, the service concept will be tried in an area that presently has no waterborne transit.

An automobile restricted zone (ARZ) is an area created in a congested portion of the city, such as the central business or shopping district, where automobile traffic is prohibited or restricted. Such a zone may range in size from a few blocks along several adjacent streets to large portions of major activity centers. There are many forms of automobile restricted zones; an ARZ might be created through the imposition of severe parking restrictions, barriers to through traffic, or a ban on all automobiles. An automobile restricted zone is expected to lead to an reduction of transit travel time and an improvement in vehicle reliability since transit vehicles will no longer be impeded by automobile congestion. In addition, an ARZ could lead to increased transit usage, decreased land requirements for parking, and decreased pollution, energy consumption, and accidents. All this would help to provide a more appealing environment for pedestrian-oriented activities on or adjoining the street.

An eighteen-month study (discussed in Chapter 8) to evaluate the feasibility of the ARZ concept and to develop initial demonstration designs in several selected cities is nearing completion.

Solicitation of interest in preparing an auto restricted zone demonstration design resulted in 45 cities submitting informational materials. Five cities were selected to develop more detailed plans: Boston, MA; Burlington, VT; Memphis, TN; Providence, RI; and Tuscon, AR. Preliminary demonstration plans have been completed for each of the five sites. A decision as to the locations and scope of ARZ demonstrations will be made in FY77.

Transit Malls

An effort closely related to the study of auto restricted zones is the evaluation of the feasibilility and cost-effectiveness of transit malls in American cities. Transit malls are streets closed to all traffic except buses and pedestrians. Transit malls are generally planned as part of downtown redevelopment, often including transit improvements focusing on the mall and frequently incorporated into a larger scheme of auto restricted zones and parking modifications.

Four sites have been chosen as a focus for evaluation activities: Minneapolis, MN; Philadelphia, PA; Portland, OR; and St. Louis, MO. The evaluation will relate the cost-effectiveness of the projects to explanatory factors in order to give guidance in the planning and design of future malls. Results will be examined to assess the impacts of transit malls on improving transit service; increasing efficiency of transit operations; encouraging transit ridership; discouraging auto use; reducing conflicts among autos, transit, pedestrians, and trucks; reducing pollution; creating or improving an environment for pedestrian and street activity; and promoting economic growth and activity.

Timed Transfer

Timed transfer focal point (TTFP) transit service is a concept in which buses on transit routes which intersect are scheduled so as to permit convenient transfers and little or no transfer wait time. The SMD Program is investigating the feasibility of this concept as a means of improving transit service in suburban locations. The onerous transfer for a trip that involves two or more transit routes puts transit

at a competitive disadvantage in comparison to the auto; thus, transit's share of the travel market for the large number of potential trips in suburban areas that may be served by a combination of two or more transit routes is extremely small.

The experience with TTFP in Vancouver, British Columbia, and Edmonton, Alberta, were examined and a paper was prepared on the findings of this review. Timed transfer focal point operations in the two Canadian cities are considered successful by the local planners and are being expanded.

In general, TTFP operates best in areas where most transit trips require a transfer and results in reduced transit travel time for those trips. However, the TTFP concept entails numerous facets which increase operating costs. Schedule adherence problems are particularly difficult in corridors of congested peak hour traffic. The location and design of TTFP facilities are also critical elements in the system operation.

Since the costs and benefits of TTFP service could not be quantified from the Vancouver and Edmonton experience, the SMD Program will conduct a demonstration of this concept to assess its merits.

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CHAPTER 3

INCREASING TRANSIT VEHICLE PRODUCTIVITY

Transit vehicle productivity is a measure of the efficiency with which transit vehicles and drivers are being utilized. Vehicle productivity is the ratio of passengers served (passenger trips or passenger miles) per unit of transportation service provided (vehicle hours or vehicle miles). Increased productivity means increased economic efficiency in the operation and scheduling of transit vehicles. Higher productivity can result in an associated decrease in the cost of each passenger trip and hence a reduced ratio of operating costs to operating revenue.

Important external benefits also come with improved transit vehicle productivity. As more people travel in fewer vehicles, roads and highways are used more efficiently. Social and environmental benefits result, such as reduced fuel consumption, reduced congestion, fewer accidents, and lower pollution rates.

Improved productivity will result from increasing the number of passengers carried without a proportionate increase in the vehicle fleet. Techniques to accomplish this include:

1. Providing an improved level of service to attract increased ridership.

2. Use of a transportation broker (see Chapter 2) to identify transportation needs and providers and better match the supply and demand.

3. More efficient dispatching of demand-responsive vehicles; automated dispatching and communications for large systems.

4. Use of subscription service for regular trips to specific destinations.

5. Spreading demand to avoid sharp peaking by introducing staggered work hours, fare reductions during offpeak, charter trips for elderly citizens during low demand periods, etc.

6. Expanded promotional efforts and improved information aids to increase transit usage.

7. Pricing policies which tend to redirect travel behavior and demand toward increasing use of high occupancy modes.

Techniques for improving transit productivity can be classified into two general areas: service strategies and pricing policies. Examples of service-oriented approaches include techniques (1-4) listed above. Pricing (and marketing) policies such as those in 5-7 refer to techniques which tend to redistribute transit demand in ways which increase vehicle productivities. In addition, pricing policies can be applied more generally to transportation facilities (roads, parking) in such a way as to divert travelers into high occupancy vehicles.

Other service-oriented approaches might involve changes to the vehicle fleet mix, such as using larger buses where the demand density is very high. Providing priority treatment to transit vehicles will enable them to make more trips per hour. Integrated fixed-route and demand-responsive systems can use small buses or taxis to provide feeder service to full-size line haul buses. Providing vans on lease to commuter groups for vanpooling from outlying suburbs obviates the need to allocate transit vehicles and drivers in these low demand areas.

Utilizing vehicles more efficiently to carry a given number of passengers can often be accomplished with more general transit management and operation strategies. This may include improved run cutting and scheduling, improved maintenance, and a modified mix of service modes and types.

An increase in transit vehicle productivity will be reflected in system parameters--passengers carried, units of transportation service provided, and costs per passenger or per unit of transportation--in different ways, depending upon the type of service and the treatment applied.

It should be noted that special services, particularly those for the handicapped and elderly, may, by their very nature, carry a limited number of passengers. Such operations generally provide door-to-door service and may even provide assistance to passengers as they enter and leave the vehicles. Eligibility may also be limited to those most in need, and demand densities for such service is generally quite low. Such special services should be judged

German Neoplan Double Deck Bus Used by the Southern California Rapid Transit District

British Leyland Double Deck Bus Used by the New York MTA

against different productivity yardsticks or in the context of different demand densities.

REVIEW OF DEMONSTRATION PROJECTS

The Service and Methods Demonstration Program is sponsoring demonstrations which employ a range of techniques for increasing vehicle productivity. The experience gained from these demonstrations has already begun to yield valuable insights into the circumstances under which a given treatment can be successful. However, the status of most of these projects is such that only limited, interim results can be reported at this time. Demonstrations planned for the future should continue to further the understanding of vehicle productivity changes.

The following discussion of current projects focuses on transit service oriented approaches to improving productivity. In a later section of this chapter dealing with future activities, a program of studies and demonstrations are described which employ pricing techniques to increase transit vehicle and transit system productivity.

A number of techniques for improving transit vehicle productivity are being demonstrated in FY76 SMD projects. The concepts include double deck buses, integrated transit services, the transportation broker, subscription bus services, and computerized dispatching for demand-responsive systems. Table 4 contains the characteristics, features, and status of these demonstrations.

Double Deck Bus

A rather basic approach for improving transit vehicle productivity is to provide larger vehicles on bus routes where the demand warrants greater passenger carrying capacity. Double deck buses can provide the added capacity. As no additional drivers are required, operating cost increases should prove to be less than proportional to that required to provide a similar capacity increase with conventional buses.

The Double Deck Bus Demonstration Project (Appendix L) is assessing the operational feasibility of the double deck bus over a range of United States transit service conditions through experience with daily revenue service. There are two different applications of double deck bus service being demonstrated at this time. Two German Neoplan double deck

TABLE 4. DEMONSTRATIONS AIMED AT IMPROVED TRANSIT VEHICLE PRODUCTIVITY

PROJECT TITLE	PROJECT LOCATION AND DEMONSTRATION DATES	PROJECT CHARACTERISTICS	TECHNIQUES EMPLOYED TO INCREASE VEHICLE PRODUCTIVITIES	STATUS
Double Deck Bus	New York City (Manhattan) Los Angeles (El Monte Busway) January 1975–December 1977	8 Double deck buses operating on 2 local Manhattan routes, characterized by short passenger trips, over-crowding, and automobile congestion; 2 double deck buses on express commuter routes, charcterized by long passenger trips and high speeds.	Increase bus size to increase capacity for less than a proportionate increase in operating cost, with no additional vehicles or drivers required.	Los Angeles buses began services in April 1975. New York City buses began service in September 1976.
Integrated Transit Services Demonstration	Westport, Connecticut July 1976–June 1978	Integration of fixed route, shared ride taxi, subscription, and handicapped and elderly demand responsive services into one transit operation; use of transportation broker to identify and match supply and demand.	Efficient utilization of multi-modal transit operation to match demand would maximize vehicle utilization and minimize operating costs; financial incentives to taxi operators may lead to improved and more efficient taxi service; improved coverage and level of service, and a considerable marketing program would increase ridership.	Demonstration services to begin in February 1977.

TABLE 4. (CONTINUED)

Taxicab Feeder to Bus Service Demonstration	St. Bernard Parish, Louisiana June 1976–May 1978	Shared ride taxis used as a feeder to fixed route buses in a low density suburb of a large metropolitan area.	Integration of efficient aspects of taxi and bus would maximize vehicle utilization and minimize operating costs; improved coverage and level of service would increase ridership.	Demonstration services to begin in February or March 1977.
Knoxville Transportation Brokerage System	Knoxville, Tennessee July 1975–July 1978	Use of transportation broker to identify and match supply and demand in a medium size city; service will be supplied by public and private providers, with the broker sponsoring a vanpool program.	The efficient use of a variety of resources to match supply and demand would maximize vehicle utilization and minimize operating costs; a considerable marketing program and the high level of service produced by tailoring supply to demand should generate a high ridership.	Brokering of commuter services has been operational since spring 1976; brokering of non-commuter services began in fall 1976
Reston Commuter Bus	Reston, Virginia In operation since 1968 (not an SMD project)	Subscription-type commuter bus service between Reston and employment areas in and around downtown Washington, DC, operated by a public non-profit corporation made up of residents of Reston.	By offering and expanding service only after adequate demand has been generated, and by obtaining drivers and vehicles only as needed through contracts with exisiting carriers, RCB has minimized costs; by providing excellent coverage and a high level of service at fares below perceived auto costs, RCB has generated a ridership that enables it to break even financially.	RCB has been contracting for service with Colonial Transit Company, a private bus company since October 1975.

TABLE 4. (CONTINUED)

COM-Bus	Los Angeles metropolitan area In operation since 1968 (not an SMD project)	Subscription commuter bus service linking residential and employment areas in the Los Angeles area; operated by a privately-owned profit-oriented corporation.	By offering and expanding service only after adequate demand has been generated, and by obtaining drivers and vehicles only as needed through contracts with existing carriers, COM-Bus has minimized costs; by providing a high level of service at fares below perceived auto costs, COM-Bus has generated a ridership that enables it to make a profit.	Operational
Integrated Transit Demonstration	Greece and Irondequoit suburbs of Rochester,NY April 1975-July 1977	Demand responsive and subscription service using small buses in medium density, medium income suburbs of a large metropolitan area.	Computerized vehicle scheduling and dispatching to maximize efficiency of vehicle operations.	Dial-A-Ride service has been in operation in Greece since 1972 Service began in Irondequoit April 1976. Computerized scheduling and dispatching became fully operational in June 1976.

buses with a capacity of 84 seated passengers plus standees have been substituted for conventional (40-50 seat) buses for some of the runs on the San Bernardino Express Busway from El Monte to the Los Angeles CBD.

In the other application, eight British Leyland buses are being operated in New York City under very different travel conditions. The buses, with a capacity of 64 seated passengers plus 19 standees, operate over two local Manhattan routes characterized by short trips, crowded vehicles, and heavy traffic congestion.

The double deck buses under both operating environments should improve transit vehicle productivity by making available additional passenger capacity at a less than proportionate increase in costs. Analyses of operating data from both sites will be completed by September 1977.

Westport Integrated Transit Services

A technique for increasing vehicle productivity which has widespread applicability is to match supply and demand more efficiently by providing a mix of service modes and sizes and types of vehicles and integrating or coordinating the different service types. The successful implementation of this concept will produce a transit operation that is heavily used, provides a high level of service, and makes efficient use of its resources. This concept is being employed in a number of demonstration settings, one of which is Westport, Connecticut (Appendix H).

The Westport Transit District (WTD), a public authority, will act as a transportation broker and will coordinate the operation of fixed-route bus service, shared-ride taxi service, special market demand-responsive services, and special market subscription bus service. WTD will launch a comprehensive campaign to market these services to the public. WTD will also act as a broker for local residents and employment centers interested in forming carpools and vanpools. WTD currently operates the fixed-route bus system, and is contracting with local taxi operators to provide shared-ride and demand-responsive services using vans owned by WTD. Within the terms of the contract, the taxi operators are being given financial incentives in the form of bonuses to improve productivity. The bonuses increase as the number of passengers carried per vehicle-hour increases.

Buses Parked at the Central Transfer Point
in Westport, Connecticut

With a mixed fleet consisting of 12-passenger vans, 16-seat mini-buses, and some large, conventional buses, WTD will coordinate deployment of a number of types of vehicles for each mode of service through a central dispatch office. Productivity can be increased in the following ways. Vehicles can be efficiently utilized to match demand, thus minimizing operating costs. Overhead and control costs will be minimized as a result of consolidating dispatching of all services into a single control room. The financial incentives given to the taxi operators to carry more passengers per vehicle-hour may encourage the taxi operators to improve their service and make it more efficient. Finally, WTD marketing efforts and the improved level of service resulting from the comprehensive and complementary service being provided throughout Westport should increase transit ridership with a less than proportionate increase in the allocation of both vehicles and other resources.

St. Bernard Parish Taxi Feeder Service

In St. Bernard Parish, Louisiana (Appendix I), the concept of integrating taxicabs with conventional and subscription bus service will be tested. The taxicabs will provide feeder service within the parish to and from the fixed-route buses at specified bus stops. Transfers will be timed to minimize waiting. At a later date, a combination taxicab feeder and express bus service operating on a subscription basis is planned.

Both the taxicabs and the present fixed-route service in St. Bernard Parish are owned and operated by the same company. Integration of the two modes providing many-to-few service with taxicabs in low demand density areas and providing fixed-route service along high demand density corridors should provide a comprehensive, high quality service. The integration of services enables the larger vehicles to be used more efficiently, and reduces overall operating costs. System productivity improvements will be reflected in terms of more passengers being carried per unit of supply and reductions in cost per passenger for a more comprehensive service.

Knoxville Transportation Brokerage System

In Knoxville, Tennessee (Appendix B), the University of Tennessee (UT), under contract to the city of Knoxville, will serve as a transportation broker, and, as such, will attempt to coordinate a wide range of public and private

transportation modes into an efficient, integrated regional network. Demand will be identified through general public marketing techniques and by working through employers, social service agencies, and other organizations to survey the travel needs of individuals within those organizations. The broker will also identify specific transportation suppliers to fill these needs. The suppliers can be either existing public or private agencies, such as the Knoxville Transit Corporation (KTC) or charter bus companies, or new suppliers, particularly individual entrepreneurs. Interested private individuals who cannot supply their own vehicle can lease city-owned vans from the broker.

The efficient use of resources should maximize vehicle utilization and operating costs. Moreover, the high level of service produced by tailoring supply to demand should generate a high ridership for a given allocation of resources.

One facet of the broker-generated service deserves special mention--the subscription van service. It is anticipated that a large percentage of the demand for broker-generated service will be in low density areas during the peak periods. KTC presently provides comprehensive fixed-route service in high density areas. It would be costly for KTC to expand its fixed-route service in these low density areas. The long pickup and distribution route makes it difficult to fill a conventional transit bus, and some residential areas are so far from work locations that a bus can make only one trip during a peak period. A new driver and bus would have to be provided to carry each increment of approximately forty commuters.

Subscription vans or vanpools will be used to provide transit to commuters from low density remote areas. One of the commuters, or a private provider, drives the van, picks up other commuters, and transports them to work and back. Door-to-door premium service is provided and total costs are covered through user charges. When a commuter drives, he rides free and the other passengers pay their share of the costs. When a private provider drives, he charges fares that are set by the broker. Fares are set so that on the average, the private provider can make a profit if he carries ten or more passengers.

Subscription Bus Projects

Subscription bus service has been introduced in several localities in the past few years. These services are

generally aimed at commuters whose urban travel needs are not adequately served by conventional mass transit services because they live in lower density areas or localities far from the CBD, or work in non-CBD employment centers. Subscription bus is particularly important because it results in increased vehicle productivity in settings where this is frequently difficult. These productivities may, nonetheless, be low when compared with the utilization of the same bus in a high-density fixed-route setting.

The efficient operation of a subscription bus service requires a sufficient number of riders traveling from a relatively concentrated area or a few park-and-ride sites to a major employment center.

Two examples of effective subscription bus service were studied during FY76. The Reston Commuter Bus (RCB) carries persons residing in Reston, Virginia, to employment areas in and around downtown Washington, D.C. In Southern California, the COM-Bus service links residential and employment areas in the Los Angeles metropolitan area. These projects are not part of the SMD program and neither receives Federal funds. However, the approaches taken by Reston and COM-Bus may be applicable elsewhere, hence they are being analyzed and documented for dissemination through the SMD program.

RCB (Appendix J) is a public non-profit corporation staffed by residents of Reston who are regular riders. COM-Bus (Appendix K) is operated by a privately-owned, profit-oriented corporation. Both RCB and COM-Bus have managed to operate in the black in an era where most transit operations are heavily subsidized. Both have been successful financially by being able to match supply and demand effectively. Both have expanded service only after adequate demand has been generated. By contracting with existing carriers, both have been able to obtain drivers and vehicles only as needed. RCB has charged fares which cover all costs, and COM-Bus has charged fares which will yield a profit (both average about $3.00 per round trip).

Fairly high transit vehicle productivity, on the order of 25 to 35 passengers per in-service vehicle-hour, are possible because of a fairly high residential demand density for trips to a major employment center. People are attracted to the service because of the high level of service offered, i.e., routes and schedules responsive to demand, express service, and buses equipped with air conditioning and reclining seats. People are willing to pay the relatively high fares because these fares are perceived

to be lower than the alternative costs of taking these rather long trips--18 miles and more--by automobile.

Subscription service, to date, has not been particularly successful for short commuter trips (less than 10 miles). The cost of providing one short trip in a peak hour does not differ much from the cost of a long trip, and passengers resist paying comparable fares for less perceived benefit. But with a coordinated program of staggered work hours in a major employment area, a subscription bus service could cover two to three routes per peak period, thus greatly improving productivity and reducing the cost to the passenger. A demonstration that incorporates this concept is now being planned (see next section, "Future Demonstrations").

Rochester Integrated Transit

A method for improving transit vehicle productivity in demand-responsive transit systems that is being examined in the Rochester Integrated Transit Service Demonstration (Appendix D) is the use of computerized scheduling and dispatching. This computerized system has the potential to produce a greater efficiency in both control room operations and vehicle routing. Vehicle productivity may increase from several aspects. From a system point of view, more efficient use of vehicles and improved communications would produce a higher ratio of passengers per vehicle hour and would increase the effective system capacity. From the point of view of individual trips, routing circuity may be reduced, producing a more favorable ratio of passenger miles (by the most direct route) per vehicle mile. In other words, the number of miles which a passenger must travel out of his way to accommodate other passengers would be minimized. Also, as the computerization achieves higher levels of service (as measured by wait times and ride times), ridership should increase, producing a further increase in vehicle productivities. Finally, improved routing and control may allow a reduction in the number of vehicles with no deterioration in service.

The computerized system became fully operational in June 1976 and is currently being used to schedule and dispatch vehicles for the dial-a-ride services that have been implemented in the Rochester suburbs of Greece and Irondequoit. Repeated vehicle breakdowns on the dial-a-ride services and the short time the computerized system has been operational make it impossible at this time to determine

Shopping Trips are Provided by Dial-A-Bus,
Demand-Responsive Service in Rochester, New York

whether the expected productivity gains can, in fact, be achieved by the computerized system in use in Rochester.

By way of comparison, a similar approach to scheduling and dispatching demand-responsive vehicles is being taken with Ann Arbor, Michigan's, Teltran system. This system is not an SMD project, but has been documented for the sake of gathering more information on the experiences of areawide integrated service (see Appendix E). Teltran is an integrated dial-a-ride and conventional fixed-route bus system with coordinated transfers. A computer assisted reservation system acts primarily as a bookkeeper, keeping track of reservations, displaying them to call takers and dispatchers, and simplifying editing. Unlike the Rochester system, the Ann Arbor computer does not perform decision-making functions. However, the Ann Arbor computer does facilitate scheduling and dispatching by increasing the efficiency of a number of call-taker and dispatcher tasks. Vehicle productivity is improved as a result of the control room's ability to handle more calls and dispatch vehicles more efficiently.

FUTURE DEMONSTRATIONS

A number of demonstrations of service strategies and pricing policies for improving transit productivity will be conducted in FY 1977 and 1978. The concepts to be demonstrated include shared-ride taxi, multiple trip subscription bus service, transportation brokering, fare reduction, fare prepayment, and road pricing.

Shared-Ride Taxi

Improved transit service, particularly in low density areas, can be provided through the use of the existing taxi fleet. Whereas taxis in conventional operation provide a high quality service, they are generally too expensive for most people to use regularly. Shared-ride taxis can provide high quality transportation service at fares considerably lower than conventional taxi fares without adversely affecting the taxi operator's profit margin. The lower fares enable more people to use taxi service. The higher demand plus the ability to group rides together enable the taxi operator to carry more passengers per vehicle-hour at little or no additional cost, thus reducing the per passenger trip cost. While the lower fares decrease the revenue per passenger, profitability is not adversely affected (and may even be improved) because the cost per

passenger trip is lower and the number of passengers carried is higher.

Demonstration projects are being planned in Arlington County, Virginia, and Nassau County, New York, to test the shared-ride taxi concept. In January 1975, Arlington County permitted the operation of shared-ride taxi service for the first time. Although the service was advertised, few riders were attracted. Under this project, Arlington County will reexamine the market for shared-ride service, completely redesign the zone and fare structure and the management of the service, and develop the framework for an advertising campaign. At the conclusion of the study the shared-ride service should be ready for operation.

The project in Nassau County is designed to improve the passenger carrying capability of the current shared-ride taxi operation, thus reducing the cost per passenger trip. The project will take the following steps in order to accomplish the required productivity gains:

- Improve the quality and capacity of shared-taxi service through the acquisition of more vehicles.
- Tie the profit margin of the private operator to productivity gains where profit per passenger will increase as overall productivity is raised.
- Reduce fares immediately to levels which will enable the private operator to make a profit once projected productivity gains are achieved, covered by project funds in the interim.
- Provide improved dispatching facilities.
- Implement an intensive promotional campaign.

Four types of service will be provided during the project: subscription commuter service to major groups of employees, feeder service to commuter rail stations, shared-taxi service during offpeak periods and offpeak subscription service for small groups such as senior citizens clubs. Arrangements have been made to subsidize the fares of the elderly, handicapped, and welfare clients.

Multiple Trip Subscription Bus Service

Past experiences with subscription bus service have shown that relatively long trip distances are needed in

order to utilize the driver and vehicle economically while charging a reasonable fare. However, by establishing a coordinated staggered working-hours program among several employers, a subscription-bus service could provide two or more trips per vehicle per peak period, thus greatly improving productivity.

A project is underway to determine the feasibility of implementing short-haul subscription bus service coordinated with a program of staggered working hours at a major employment center in El Segundo, California. The impact of this coordinated service will be projected for employers, employees, and competing modes of commuter travel. In addition, the possibility of expansion of the concept to a wider area is being studied.

Evidence from this study indicates that a multiple-trip subscription bus service is a feasible concept. As a consequence, the design of a full-scale demonstration in the Los Angeles area is currently being developed.

Transportation Broker

A study is currently underway in Pittsburgh, Pennsylvania, to determine the feasibility of introducing a transportation broker into the local institutional structure whose purpose will be to stimulate the demand and supply of paratransit services by consolidating trips currently made by private auto. The transportation broker concept, which is currently being tested in the Knoxville and Westport demonstration projects, appears to have widespread applicability. However, the institutional and regulatory framework in which a transportation broker will operate, may vary dramatically between sites. In Knoxville and Westport, the city exerts considerable control over the current transportation providers and can regulate the local taxi companies. Thus, it has considerable influence in coordinating the transportation broker functions.

In Pittsburgh, the city has no such influence. The local transit authority is an independent body, and the taxi companies are regulated by the state Public Utilities Commission. Transportation broker functions will have to be coordinated either by the local Port Authority or a private, non-profit institution.

The Pittsburgh study will examine the institutional and regulatory framework into which a transportation broker is to be introduced, design the specific functions, services

and management structure for the broker, identify potential providers of services, and outline a marketing approach.

Transportation Pricing Policies

Pricing policies can improve transit productivity and increase the efficiency of transportation systems by directly and deliberately redirecting travel behavior and demand in favor of high occupancy modes. In the past, the pricing of urban transportation service has been direct for mass transportation (i.e., fares to users) and less direct for the highway system (e.g., gas taxes and registration fees). It has not generally been used as a mechanism to shape travel choices to meet various public policy objectives, most importantly the alleviation of urban transport problems.

The historical government response to these problems has been to increase supply (e.g., freeway construction, transit system development, new technology) with insufficient consideration for the social consequences of individual travel behavior. Whereas economists have for some time been in favor of using pricing policies to assess individuals for their contribution to the urban transport problems, only in a very few instances has pricing been used as a deliberate mechanism to alter travel demand between modes, geographical areas, or time periods.

For example, some transit agencies have instituted policies of reduced or free fare followed by service improvements under various operating conditions. Although limited in scope, these innovations have shown their potential for increasing transit ridership. Proposals involving concepts such as differential parking rates, tolls, and direct user charges have been made and often implemented to restrict the single occupant auto and encourage high occupancy modes such as carpools and fixed-route systems.

The SMD Transportation Pricing Program is a coordinated effort to embark on a series of experiments in metropolitan communities of different character to demonstrate and evaluate to what extent a range of pricing policies can alleviate these urban problems and help achieve major social goals. All of the following projects are fundamentally aimed at the objective of improved transportation system productivity.

Transit Fare and Service Policies Demonstrations

Three types of separate but closely related activities have been brought together under the heading of fare and service policies demonstrations to be implemented by the SMD Program; a) fare-free activities proposed by Title II of the National Mass Transportation Assistance Act of 1974 which deal with the complete abolition of fares under different circumstances, b) fare and service variation demonstrations conceptualized by the SMD Program to test different levels of transit price and service improvements, and c) experiments in fare prepayment methods.

The bringing together of these activities has permitted a more objective and broader view of the available range of possible price and service policies. A sound experimental program has been designed that defines promising concepts. Thus, the activities under this area now include the whole range of fare and service policies including the complete abolition of fares on a permanent systemwide basis to variations such as the reduction or elimination of fares for a specific time of the day or as a special or promotional purpose to acquaint new riders with the transit system in hopes of retaining their patronage.

Offpeak Free Fare

A number of cities have introduced reduced fares at offpeak periods as a way of inducing some riders to shift from the congested peak period to the uncongested offpeak. Most commuters have little choice over the times at which they travel to work. But shoppers and others on personal trips, who make up as much as 20 percent of the riders in rush hours, can be diverted to offpeak trips by fare reductions. This diversion of riders has the double effect of reducing crowding at rush hour and increasing ridership at offpeak times when excess capacity exists in transit vehicles, and additional riders can be carried at very little additional cost. Reduced fares may also attract new riders to the system. If a system increases its passenger miles without adding vehicle miles, its productivity has increased. Fare reductions at offpeak periods may thus offer an alternative way of improving vehicle productivity. The SMD Program is planning demonstrations of offpeak free fare in Mercer County, New Jersey, and Salt Lake City, Utah. In Salt Lake City there is currently free fare offpeak service for the elderly, and Mercer County has a relatively low offpeak fare of $0.15. Though the fare reduction will be marginal, the perceived savings of free fare policies has

the potential to encourage transit ridership and diversion from peak hour travel.

These demonstrations will provide the opportunity to study the basic technical issues of fare-free transit as they apply to offpeak service and to provide the basis for making future comparisons with peak and offpeak fare reduction. Since the fare reduction will apply only to offpeak hours, there will be no planned service improvements such as the purchase of any additional equipment. It is expected that existing unused capacity will be able to absorb any increase in ridership that may result from the fare abolition.

In addition, pertinent information will be obtained concerning the cost of operating and maintaining such a fare-free system including direct cost and benefits from the user and non-user perspective. Alternative funding sources will also be explored to support the offpeak fare-free operations.

The demonstrations of free fare services will seek to determine the extent of increases in ridership, the extent of frivolous riding (by youth), impact of increased ridership on boarding times and trip times, impacts on costs of maintenance and operation, the extent of mode shifts, and tripmaking characteristics of users and non-users. Economic impacts on downtown businesses will also be investigated.

Central Area Free-Fare

In recent years several cities have abolished fares for transit travel entirely within the central business district (CBD). The outcomes appear to have been mixed. In Seattle, for example, a one-year experiment was deemed successful and allowed to continue; in Dallas, on the other hand, the measure has been abolished because of enforcement problems. General knowledge is thus not available regarding the impacts of this concept on social, economic, and operational aspects.

Two concepts are being planned to test the effects of complete fare elimination in central areas. One involves fare abolition with no planned service improvements in a limited area within the CBD where there is existing service and excess vehicle capacity. The second concept involves a larger area in the downtown. Fare abolitions in this case are designed to enhance the mobility within the downtown and

are expected to be followed by controlled service improvements.

These demonstrations will provide guidelines to the transit industry on how to best select downtown zones that support a free-fare policy and on the administration and operation of this concept. The impacts on transit users and non-users, economic activity, and vehicular and pedestrian volume will also be studied.

Transit Fare Prepayment

Specifically associated with the objective of improving the transit vehicle productivity is a comprehensive demonstration on fare prepayment methods. A rekindling of interest in fare prepayment methods and their possible benefits began late in the 1960's. In addition to the information gained from the recently completed study of prepayment programs discussed in Chapter 7, some basic questions remain unanswered:

1. What prepayment methods are preferred by different sectors of the transportation market?

2. What minimum discount levels are effective in increasing transit demand?

3. What distribution methods are most efficient?

The objective of future demonstrations in this area is to implement and test in a mix of city environments different types of prepayment plans under various discount levels and distribution methods. Changes in ridership and revenue data will be analyzed to estimate how demand is related to price and convenience. All costs associated with fare receipts handling and accounting will be studied to determine the effects of providing different discount levels.

Reduced Price Promotions

One possible way of expanding fare prepayment would be to offer a temporary price discount as a stimulant to sales. The objectives of such a discount would be several. First, new riders hopefully would be attracted to transit (thereby gaining a familiarity with the service characteristics of the system and the relevance of the service to their own travel patterns), and a portion of these newcomers would

remain patrons after the discount period ended. Secondly, some existing patrons would switch from cash payment to prepayment, and would not switch back again after the temporary discount ends. And thirdly, the discount promotion may help to augment a positive public image of the transit system, as one which is using modern marketing techniques in an aggressive approach to increasing its share of the travel market.

Transit fare prepayment (TFP) demonstrations are being considered in Phoenix, AZ, and Austin, TX. At both sites an increase in promotional efforts of already existing prepayment schemes is planned. A temporary discount on transit fare prepayment instruments is expected to induce existing riders to change from cash fares to prepayment instruments and to attract new riders. Two reduced price promotions will be offered in both demonstration sites with varying discounts. By varying the discount price and form of marketing promotion, information will be obtained on an effective strategy of implementing reduced transit fare prepayment instruments. The relative user preference to different types of prepayment will be assessed.

In Phoenix, the scope of the proposed demonstration project involves the promotion of a reduced transit fare prepayment to be used within the framework of existing transit service. In addition, a new TFP will be introduced and marketed along with the existing TFPs. There are no planned service adjustments during the project and service variables will be minimized so that the effects of limited, reduced fare prepayment instruments on ridership patterns may be more clearly discerned.

In Austin, an intensive marketing program will be conducted to demonstrate the potential benefits to the transit system and the rider of promoting transit fare prepayment. The demonstration will be directed at determining the impact of intensive promotion of reduced price passes on the level of new and present ridership, identifying characteristics of pass ridership, identifying marketing techniques which are successful in achieving higher levels of ridership and pass sales through attraction of specific market segments, and determining the impact of increased utilization of fare prepayment on system operations and administrative costs.

Two separate promotions of prepaid passes and tickets will be conducted in Austin. The prepaid instruments will be marketed through approximately eighty outlets at significantly reduced rates (30% to 40% off regular price).

The pass sales will be promoted through a comprehensive advertising effort. In conjunction with the promotions, surveys of pass purchasers, other transit riders, and the general public will be conducted.

Promotion of Prepayment through Employers

In a small number of the cities where the transit system provides for some form of fare prepayment, efforts have been made to promote sales through major employers. The schemes for doing this have varied in their details, but the unifying concept is that employees are able to purchase prepayment instruments -- be they passes, permits, multiple-ride tickets, or even tokens -- at their place of work, with a minimum of personal inconvenience. Some of the variations on this basic idea which have been either tried or suggested include:

- Payment by payroll deduction

- Subsidization by employers -
  An employer may elect to contribute part or all of the price, as an employee benefit. The company may offer such a benefit as an alternative to, or in addition to, providing subsidized parking facilities at the workplace.

- Bulk price reductions to employers -
  By purchasing passes in bulk and being responsible for their distribution, the employer is reducing some of the administrative burden for the transit operator. The transit agency can thus provide a discount and the employer may, in turn, elect to pass these savings on to employees.

- Discounted passes for offpeak travel -
  The transit agency may seek to spread the peak-hour loads and encourage staggering of work schedules by offering a form of prepayment instrument which is only valid for rides during the offpeak hours. These could be offered to employers (and to the general public) at substantial discounts below the price of equivalent passes valid for riding at any time.

In Sacramento, CA, a demonstration is being designed to test the impact on pass sales and transit riding of various methods of marketing monthly passes through employers. The ultimate goal is to increase transit ridership through

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In a small number of the cities where the transit system provides for some form of fare prepayment, efforts have been made to promote sales through major employers. The schemes for doing this have varied in their details, but the unifying concept is that employees are able to purchase prepayment instruments -- be they passes, permits, multiple-ride tickets, or even tokens -- at their place of work, with a minimum of personal inconvenience. Some of the variations on this basic idea which have been either tried or suggested include:

- Payment by payroll deduction

- Subsidization by employers -
  An employer may elect to contribute part or all of the price, as an employee benefit. The company may offer such a benefit as an alternative to, or in addition to, providing subsidized parking facilities at the workplace.

- Bulk price reductions to employers -
  By purchasing passes in bulk and being responsible for their distribution, the employer is reducing some of the administrative burden for the transit operator. The transit agency can thus provide a discount and the employer may, in turn, elect to pass these savings on to employees.

- Discounted passes for offpeak travel -
  The transit agency may seek to spread the peak-hour loads and encourage staggering of work schedules by offering a form of prepayment instrument which is only valid for rides during the offpeak hours. These could be offered to employers (and to the general public) at substantial discounts below the price of equivalent passes valid for riding at any time.

In Sacramento, CA, a demonstration is being designed to test the impact on pass sales and transit riding of various methods of marketing monthly passes through employers. The ultimate goal is to increase transit ridership through

extended availability of prepaid passes. Project activities will include a public information campaign, solicitation of suitable employers, and the distribution of passes to the selected employers. Various purchasing options will be encouraged; e.g., payroll deduction, simple on-site distribution, provision of passes as an employee fringe benefit, provision of passes as an alternative to company provided parking, and provision of passes to employees as a negotiated fringe benefit.

The Cost-Effectiveness of Various Transit Service Improvements

While a great deal is already known about the demand response to transit fare changes, much less is known about the patronage response to service quality changes of various kinds. A question of key interest to a transit agency is often: Given the configuration of our existing system and the characteristics of the area which we serve, what operating changes are likely to produce the largest ridership gains at the lowest cost?

Research currently underway sponsored by the SMD Program is attempting to address this question by analyzing the experience of the San Diego Transit Corporation in improving service levels and lowering fares. This analysis is trying to identify how operating changes of various types have influenced the patronage on selected routes and at what cost.

One or more experimental demonstrations with controlled service improvements will be conducted in order to add to the knowledge base concerning this topic. The demonstrations would be preceded by the type of analysis being carried out for the San Diego system in order to identify those service changes which would be most cost-effective in boosting ridership. These changes would then be planned and put into effect on a controlled basis so that their impacts may be monitored.

Potential sites for this type of demonstration will require a flexible, well-managed transit system with relatively good operating data base. The experiments will identify the service types and levels that cause the most increases in transit ridership and productivity, especially if such increases come from previous automobile users. Also, limiting levels that do not cause any further increase in ridership or productivity will be identified. An overall evaluation will be made of the effect of these price and

service changes in increasing mobility for the various sectors of the transportation market.

In conjunction with this, a study is being made of policies and procedures employed by several major transit operators for developing routes, schedules, and fare structures, and to identify specific research or demonstration projects which would advance the state-of-the-art in this area.

Road Pricing Demonstrations

The transportation system in congested cities cannot be substantially improved unless it has more street space with which to increase service speeds, reliability, and productivity in terms of person movement. Congestion pricing, which levies special charges on vehicles using congested streets, is potentially an effective means of providing this space. Because it can be focused on the congested area, it is likely to be more effective than other more general changes in prices or taxes, such as increasing the price of gas or reducing transit fares. The advantages of congestion pricing lie largely in making highway capacity available for high occupancy transportation modes, including not only conventional transit but also various forms of paratransit -- all means, in fact, which use street space economically. Congestion pricing is thus a leading element in what must be a package of prospective improvements.

The general objective of the approach is to improve urban transportation efficiency, reduce air pollution and conserve fuel by reducing the total demand for motor vehicle travel by encouraging the use of high-occupancy modes and diverting some peak-hour travel to non-peak periods. It is also likely that this approach could generate signficant revenues that could be used for supporting transit service improvements and other measures to mitigate any adverse impacts of the scheme.

Congestion pricing could take many forms: for example, supplementary licenses to enter a congested zone, surcharges on parking, or metering of vehicles. Conceptually one of the most attractive alternatives is the area use charge, or, in other words, a license to use a specified zone. Such a scheme can be designed to affect the principal factors important in controling congestion, namely peak period traffic and vehicle occupancies. Compared to the other alternative forms of congestion pricing, the area use charge appears to be easier and less expensive to implement.

The level of charge will depend on the initial level of congestion and the desired improvements. Congestion has dimensions of intensity, duration, and incidence. Slower traffic, longer snarl-ups, wider areas over which congestion occurs, and greater desired reductions in vehicle traffic will require higher charges and produce greater revenues. Obviously, how much would be charged depends on the existing conditions in the city in question and the local need for reduction in traffic. Ultimately, the types of charges to be implemented and their levels are local decisions.

In a demonstration approach, the congested area of the city would be designated as the "priced area" during certain hours of heavy travel. Private automobile drivers desiring to travel in the designated area during the congested periods would be required to purchase a special license and display it prominently. At the same time, changes in public transportation, broadly defined, will be initiated. The essential requirements will be to increase vehicle occupancy. Current automobile users have very varied trip origins, destinations, and service needs. Thus a wide range of specific measures will be appropriate; e.g., encouragement of carpooling, vanpooling, shared taxi and other para-transit forms as well as expanding bus service. The whole range would be implemented as a complementary set.

It is anticipated that a preliminary anslysis will be necessary to design the licensing scheme, to determine the level of charge, to develop the public transportation improvement plan, and to estimate the impacts of implementing the package. Such an analysis would provide the locality with the information necessary to judge the merits of the approach and provide guidance toward the institutional changes that will be necessary for successful implementation of the package.

The analysis of impacts would determine how street capacity relates to public transportation provision and consider what can be provided at different levels of traffic restraint. The price charged to low occupancy vehicles will be that necessary to produce a given improvement in traffic flow. Thus the price will be based mainly on the variation in use predicted between the public transportation modes as improved and the low occupancy vehicles as a function of the traffic conditions and cost that would prevail.

Initially, about five sites that express interest in this concept will be selected for further study. The Department will fund a consultant to develop, in cooperation with each of the sites selected, preliminary sketch designs

of the program. These sketch designs will include an outline of the actual implementation, administrative and enforcement plans, and will make coarse estimates of the most important impacts on traffic patterns and volumes, including modal shifts, travel times and costs by different modes. The analysis will also take into account possible effects of the congestion charges on downtown activities, mobility of the poor, and on local finances with respect to additional revenues generated from the license charges.

In this past year several preliminary analyses have been performed to determine the feasibility of implementing road pricing demonstrations in selected cities. The results of the analyses were presented to local decision-makers and their staff. A synopsis of these analyses is presented in the following paragraphs.

In Madison, Wisconsin, three broad pricing strategies are being considered. One, a charge for automobile use anywhere within the City of Madison for either all or part of the day, is general in coverage. The other two are directed at the specific smaller area which is recognized as having the greatest problems from auto traffic and the greatest potential for attracting transit riders. This area is the core of the city, containing the state capitol and the University of Wisconsin.

Since overall coverage of transit routes in Madison is now quite good, it is likely that service improvements would not take the form of new routes. Rather the service expansion would include increased peak period frequency of service on existing routes. Some additional park-and-ride lots can also be provided. These will be served by shuttle buses operating at frequent intervals along routes connecting the lots and the core. Finally, additional express services from outlying portions on existing routes can be provided.

The area user charge strategies, particularly those that would charge all vehicles, would produce significant traffic reduction in the core and generate adequate revenues for significant transit service improvement. Variation of this concept (reduced charge levels and/or application to only drive alone and two-occupant vehicles) would result in different levels of revenues and traffic reduction. Implementation of such a strategy would also provide useful information about implementation and enforcement that UMTA is seeking.

The road user charge applied to the entire urban area would mitigate adverse impacts on any specific location. It would not, however, provide significant traffic reduction either in any particular location or in the urbanized area in the aggregate charge scheme. This urban areawide strategy may be viewed primarily as a method for revenue generation rather than traffic reduction.

Based on these considerations, the following transportation improvement alternatives appear to be attractive:

1. Parking surcharge coupled with transit improvements.

2. Pricing of all autos entering the core area at a rate of about $1/day, coupled with transit improvements.

3. Pricing of drive alone vehicles entering the core area at a rate of $2/day.

In Berkely, California, a feasibility study was conducted to determine whether road pricing could be a component of a transportation program whose main goals were other than congestion relief. Rather, goals were more oriented toward preserving amenities of residential neighborhoods by reducing through traffic, reducing auto use by diverting more travelers to transit, and producing revenues which would support major increases in coverage and level of service of the local transit system.

As a result of the analysis of various strategies, the recommended alternative is a city-wide pricing program in the morning peak with morning and afternoon transit improvements composed of extensive local bus service and park-and-ride lots. Transit ridership would increase by about 70 percent. Over $45,000 per day would be raised from pricing to pay for the park-and-ride lots and any other subsidies required for the transit service. Depending on the available money, transit service could also be augmented in the offpeak hours.

Similar analyses were performed for Honolulu, Hawaii. The two pricing options considered were aimed at reducing congestion and alleviating problems related to inadequate parking capacity and the impacts of planned pedestrian amenities (wider sidewalks, etc.) on traffic conditions.

One option analyzed involved requiring all autos traveling in the core area during the two-hour morning peak period to purchase a daily license costing $1.00; or only charging single occupant autos; or a combination of the above where single occupant autos were charged more than those with passengers. Peak period transit service frequency would be doubled. Results indicate 23 to 34 percent increase in transit trips and a 12 to 24 percent reduction in peak period traffic in the core area. In addition, net annual revenues of up to 1.3 million would be obtained over and above the program costs and the cost of transit operations.

In the other option, autos traveling into the Waikiki beach area would be charged a daily license fee of $1.00 or $2.00. Transit service frequencies of twice the current peak period headways would be provided during the entire day. Results from analyzing this option indicate a 14 to 19 percent reduction in daily traffic in the Waikiki area and a 64 to 80 percent increase in Waikiki transit trips. Net annual revenues would range from 9 to 21 million dollars.

Corridor and Spot Pricing

In corridor pricing, low occupancy vehicles along an urban corridor are selectively priced. Conceptually, this program is very similar to the cordon crossing or areawide road user charges except that the focus of the demonstration here would be a travel corridor rather than a downtown area. In practice this would involve pricing of automobiles using a major expressway, artery, or a river crossing. Such a demonstration would not provide information about the impacts of prices on downtown business activity, but would provide valuable information on how motorists might shift travel times, modes, or routes.

Spot pricing, which is even more localized than the foregoing, involves pricing the use of congested or trouble spots such as expressway entrance and exit ramps, major intersections in central cities, or access points to major activity centers such as stadia or entertainment complexes.

Demonstrations are being planned for the concepts of corridor and spot pricing, which are an extension of the idea of areawide congestion pricing mentioned above. While these concepts are more feasible to implement politically, they are more narrow and have less impact on congestion.

Pricing of Parking Facilities

A study was also completed to provide the necessary background to develop a project concept for a comprehensive demonstration of parking pricing strategies. This study showed the potential of parking policies for reducing the use of low occupancy vehicles in the highly congested centers of our cities. It summarized recent experience in this area and pointed out the advantages and disadvantages of implementing different parking policies. The study delineated the types of trips and the proportion of the total urban travel that might be affected. It discussed difficulties in implementing certain policies and questions of enforcement. Political and institutional forces that have impacted adoption of parking policies were also pointed out. Recommendations of parking strategies that need to be demonstrated were made.

Comprehensive demonstrations of parking pricing strategies designed to control the heavy volume of single occupant inbound traffic are being planned.

All parking (on and off-street, public and private) in a designated area will be charged a fee that varies according to the time of day, the duration of parking, and the number of occupants in the vehicle. Any parked vehicle will be required to display a specially purchased sticker or license much the same as in the areawide or cordon-crossing schemes, except that here the enforcement is carried out on all parked vehicles similar to parking meter enforcement. Special cooperation for implementation and enforcement will be required from operators of public and private lots with attendants. For on-street parking, special areas may be designated for high occupancy vehicles, and differential rates may be charged by controlling the meter rates or using specially designed stickers.

SUMMARY

Most of the transit projects discussed in this chapter have not yet begun operations or are in the process of starting up. However, some important points can be made.

As a rule, the projects studied have attempted, or will be attempting, to match supply with demand and to utilize that supply more efficiently. This is being attempted in many projects by integrating and/or coordinating the operation of many different service modes, sometimes through a transportation broker. Some projects being planned are

attempting to shift demand to match a supply that can be utilized efficiently, e.g., offpeak free fare and staggered working hours. Whereas the Double-Deck Bus project is primarily attempting to utilize supply more efficiently, it is not critical that it try to match supply with demand at the particular demonstration sites under investigation. If the double-deck bus concept is found to be viable, then sites can be selected where the demand will match the supply.

Some of the projects studied involve a private provider. The private provider's interests will usually, but not always, coincide with the goals of matching supply with demand and of utilizing that supply more efficiently. For example, a taxi operator involved in a shared-ride taxi demonstration may not want to serve the increased demand generated by the lower fares for shared rides if he cannot maintain or improve his profit margin by carrying the additional volume.

With both the Reston and COM-Bus subscription services, it was in the transit operator's best interests to both match supply and demand and utilize that supply efficiently. As a result, Reston has been able to cover costs with revenues, and COM-Bus has been realizing profits. Specifically, both have been successful financially because:

1) They served areas where there was a fairly high residential demand density for trips to a major employment center.

2) They served rather long trips, for which they were able to charge relatively high fares. These fares were perceived by their passengers to be lower than the alternative costs of taking these trips by auto. By charging these fares, they were able to cover their costs.

3) The nature of the origins, destinations, and trip lengths enabled them to provide a high level of service.

4) By contracting for service with existing carriers, they were able to obtain drivers and vehicles only as they were needed. With this flexibility on the supply side, they offered and expanded service only after adequate demand had been generated.

From the evidence at hand, it appears that subscription-type bus service is a viable concept when the

conditions just outlined exist. However, institutional and regulatory constraints may complicate the implementation of this service in other communities.

Demonstrations of fare reductions and free fare in the downtown area are intended to provide a source of data for better understanding of the effects of transit fare reductions on transit productivity, transit usage, diversion from auto to transit, and economic activity in downtown areas.

The demonstrations of transit fare prepayment provide an opportunity of not only increasing vehicle productivity by increasing ridership, but also to begin to develop a market strategy where integration of fares may be possible across modes (fixed transit, taxi, paratransit) and thus contribute to improving the transportation efficiency of the overall area.

Demonstrations with controlled service improvements will be studied to compare the impacts of increased service levels with the impacts of fare reductions, prepayment, discount promotions upon transit usage, and productivity.

Road pricing and parking pricing demonstration projects have the potential of reducing congestion, increasing transit productivities, supporting increased levels of transit service, and providing additional revenues which can be used to finance other transportation improvements.

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CHAPTER 4

IMPROVED TRANSIT SERVICE FOR THE TRANSIT DEPENDENT

Those who, because of age, income, or disabilities must rely on public transportation, i.e., who do not have use of automobiles except as passengers, are termed "transit dependents." The following groups fall within this definition:

- Young -- persons with independent mobility needs but without access to an automobile except as a passenger.
- Old -- persons who have reached advanced years or retirement status, living on reduced incomes and possibly without access to an automobile except as a passenger.
- Poor -- persons whose incomes are under the poverty threshold and who therefore have minimal travel budgets.
- Handicapped -- disabled persons who require special assistance or special vehicles to travel.

In urban areas this class of people looks to public transit to meet their travel needs. The economic constraints on this population generally mean that they have no automobile because of the high costs of ownership and operation. Taxis, too, are normally too expensive for regular travel. If disabled, these individuals may face the separate problem of having physical difficulty using most forms of auto transportation. Finally, even if the individuals are able to make use of automobile rides furnished by others, the degree to which they can rely upon such services being available when needed is still another factor limiting their independence.

Public transit's failure to be responsive to the travel needs of the elderly and handicapped prompted an amendment in early 1970 to the Urban Mass Transportation Act now known as Section 16. This amendment declared as national policy that elderly and handicapped are entitled to the same rights as other persons in utilizing mass transortation services and facilities. It stipulated that special efforts were to be made in the planning and design of these services and facilities that would assure their availability and

effective utilization. The response to this legislation has been varied and based on differing opinions about the ability of conventional transit to meet these specialized needs.

The thrust of the demonstration projects reported in this chapter has been to develop and test concepts that can serve the travel needs of the elderly and handicapped population. For a market segment whose travel is for personal business, medical, shopping and social/recreational purposes, and for whom access is a significant problem, travel needs are frequently met by some type of door-to-door, demand-responsive service. Many tests have been made of door-to-door services across sites with widely varying characteristics. Since such services would not carry peak-hour ridership densities, the need is for smaller vehicles, usually vans and small buses, that offer the additional advantage of maneuverability. To accommodate physical disabilities, design emphasis has been placed on ease of ingress, egress, and safe comfortable riding conditions. These designs use lowered steps, improved handrails and stanchions, adequate seating, and wheelchair lift devices. Other aspects of providing specialized services which are just as important as the physical service are the problems of determining operator and user cost responsibilities and payment techniques; coordination of government, operator, and interest groups; and successfully marketing the system to the public. The demonstrations form a useful context for assessing the effectiveness of both the technology and administrative aspects of providing a specialized service. The remainder of this chapter describes in greater detail the structure and accomplishments of the demonstrations, as well as the lessons learned.

SERVICE ISSUES

Travel Behavior

Developing improved transit service to the transit dependent through demonstrations is a rational approach to understanding a complex problem for which there is very little existing knowledge. For example, we know surprisingly little about the travel demand behavior of this population. Each trip is the result of a decision that involves simultaneous consideration of the purpose, destination, time of day, and available modes of travel. Should the individual's circumstances place restrictions on any of these components, some compromise is generally necessary in making the trip, if in fact it can be made at

all. The relative importance of mode choice factors such as access, cost, and physical characteristics is one area where more information is necessary. More information is also necessary about the elderly and handicapped travel purposes and unmet travel needs. Another unexplored aspect of travel behavior is in the choice of destination, where the transit dependent may have to be satisfied with a more easily accessed but less desirable destination. Finally, the number of trips that would be taken with improved service needs to be established. Evidence suggests that much of this group's demand is latent, or as yet unexhibited.

Service Supply Aspects

Techniques are being developed in the area of equipment and service models. Only an everyday operating environment offers the appropriate conditions for testing the adequacy of special vehicle designs, as well as the reliability and cost characteristics of non-mass produced equipment. Operating methods to provide effective and productive door-to-door services are being developed and refined. The following alternative service concepts can be used to supply transportation to meet the special needs of the transit handicapped:

- Service to handicapped and elderly by a door-to-door transit system serving the entire community.
- Special door-to-door service for an eligible transit dependent market. In this case the general public may have other available transit modes, i.e., fixed-route bus, rail, etc.
- Special door-to-door service for an eligible transit dependent market with sufficient surplus capacity to serve a limited segment of the general public.
- Fixed-route transit system with special equipment on some or all of the vehicles to accommodate the transit handicapped.
- Door-to-door feeder and distribution service for transit handicapped which is integrated with fixed-route and fixed-schedule buses equipped to serve the disabled.

The optimum service model can vary significantly with respect to service area size, density of population served,

mobility characteristics of the target group, distribution of destinations, and local cost structures.

Institutional Factors

The final major area of uncertainty being addressed by the demonstrations is the political and administrative fabric within which such services will be implemented and maintained. Here there are several major issues to be analyzed and understood. One issue is to compare the advantages and disadvantages of providing special services through the public (existing public transit operators) vs. the private (generally taxi) sector, or to consider combinations of these approaches. Questions of costs, reliability, and competition are all of key interest. Tied closely to these basic organizational uncertainties are questions of the appropriate level and type of funding, and the determination of user charges. It is generally agreed that lower fares are important to a disadvantaged clientele and there are a number of ways of accomplishing this if a subsidy is required.

Subsidies distributed from the user side are a relatively new approach which is being developed. In this case, users can purchase transportation vouchers or tokens at a price below their face value. Transportation providers accept these vouchers as payment for transportation services and then redeem them at face value from the public agency. The subsidy, then, is passed along to the provider only when a traveler is served, and this acts as an incentive for the provider to offer attractive service rather than to take the subsidy for granted. In this kind of market, operators must present an efficient and competitive service in order to collect subsidy benefits.

Another issue is how best to provide transportation services to the medical and social service institutions that administer programs for the elderly and handicapped. Many of these institutions provide their own form of transportation services. There seems to be great potential in coordinating the many and disparate ongoing transportation services and funding mechanisms of these agencies into a unified and more effective centralized program that eliminates redundancy and inefficiency without sacrificing the objectives and flexibility.

EVOLUTION OF THE PROGRAM

For several years, UMTA demonstration programs have been addressing the objective of improved transportation services to the elderly and handicapped, as an important class of transit dependents. These demonstrations, first through the Service Development Program and since 1975, through the Service and Methods Demonstration Program, have broadened from simply the provision of specialized services to improved techniques for delivering these services.

At the inception of the Service Development Program in 1971, little was known about the travel patterns of the elderly and handicapped, the importance of various service attributes and level of service, and the impacts of geography and demand density. Moreover, while door-to-door demand responsive transportation had been applied for general population use, the feasibility of such techniques for mobility limited groups was in question. Consequently, early demonstrations were quite basic in design and objective. They encompassed several types of door-to-door service across a variety of demonstration sites. Demonstration demand-responsive services varied in level of service from site to site, both in terms of the lead time required for service delivery as well as the actual trip time characteristics. Most systems required some advance reservation for servicing a phone-in trip request, but some operations permitted requests for immediate service. As their principal achievement, these demonstrations made available information on the interactive effects of basic transit features and site characteristics on the economics and effectiveness of providing such services.

As experience accumulated in the application of these basic concepts, opportunities for improvement and innovation appeared. In some experiments, for example, combining special services with either limited or extensive availability of the demand-responsive system to the general public is being tested as a way of improving the productivity and hence the economic appeal to the local provider. In addition, more emphasis is being given to the proper definition of the target market and to ensure, through eligibility and registration procedures, that transportation supply will be adequate to serve those most in need.

The early demonstrations were mostly conducted through transit operating agencies. More recently, UMTA has broadened the range of potential operators that may participate in its funding program and more emphasis is

being given to utilizing taxi operators to provide service and to coordinating among existing social service agency transportation resources. This approach makes more efficient utilization of existing resources and can lead to a lower cost per passenger trip.

Another approach developed in response to the problem of providing adequate capacity and coverage involves partitioning the service area into sectors or zones that are serviced intensively, only on specific days. This leads to an understanding of the ability of this population to trade a highly unpredictable short notice service for one that is much more certain in its delivery, but forces the user to plan ahead. To the extent that scheduling makes demand more predictable, scheduling can improve both level of service to the user and efficiency for the supplier.

There are additional concepts being developed to improve the efficiency of demand-responsive services. Here again, the aim is to use the same system resources, but make them available to more people and more responsive to those whom it serves. One approach has been to use a "broker" to arrange group rides which make maximum use of a single vehicle trip and offer some certainty in service delivery. The broker can choose from available resources such as social service agency transportation or taxis.

On another front, some demonstrations involve innovative techniques for computing and collecting fares. The objectives of these innovations are to improve the management of subsidies and also to collect monitoring data on the user population. Credit card fare systems, third party billing to social service agencies paying a percentage of the travel cost, and user-side subsidies are techniques being tested in varying locales.

In summary, the family of demonstrations of improved service to transit dependents has established baseline knowledge of important system components and has developed a number of refinements in the management of these components. Whereas most of the achievements mentioned have dealt directly with either service supply or the institutional setting for implementing and operating such systems, much is being learned about the travel needs and behavior of the elderly and handicapped.

Future demonstrations will carry these concepts still further. By replicating promising service concepts at other sites, important characteristics whose effects have not yet been fully determined will contribute to improving the basic

service models. In some cases, replication is planned for larger cities for further testing in higher density settings which have more complex institutional infrastructures. Additional information will also be accumulated on the transferability and potential impacts of the innovations. New applications of the credit-card fare system, user-side subsidies, and private taxi services are planned for demonstrations to start in the near future. More work will be done on the coordination of health and social service agency transportation needs and programs to determine whether such coordinated service is a more productive use of agency funds. Results from all these demonstrations will expand the understanding of demand and mobility characteristics of elderly and handicapped users.

Inner cities and urban neighborhoods contain a high proportion of transit dependents of all ages. Many families in these areas have severe mobility problems stemming from lower auto ownership rates and inadequacy of public transit for some of their trip purposes and destinations.

The development of demonstration concepts to address these needs will begin in FY77 with a study and planning effort. Data on travel needs and tripmaking habits will be analyzed to determine major deficiencies by trip purpose. Alternative solutions will be developed which propose both the transportation service type and appropriate institutional structure.

Part of the study will focus on the potential for using existing neighborhood organizations and citizen's groups to organize neighborhood level paratransit services. Providers could include local taxi operators, volunteers, or other community based systems. One aim of the study will be to determine how local transportation can help to achieve viable community development and revitalization, especially for working class, ethnic residents of urban neighborhoods.

The three most promising demonstration concepts will be selected in the form of site specific project designs and implemented during FY78-79.

REVIEW OF DEMONSTRATION PROJECTS

This section presents a review of the nine current demonstration projects. Some of these projects are still in operation as demonstrations, others are in the implementation phase, and still others were completed during FY76. The project sites and phasing are shown in Table 5. Table 6

presents an overview of the basic components of each project's design. Project results are shown in Table 7. They are grouped into five categories: level of service, market penetration, user profile, ridership patterns, and system economics. These results are discussed in the project reviews that follow. More detailed descriptions of each project, including the findings, are contained in the project summaries in the Appendix.

Syracuse, New York - Call-A-Bus

The Syracuse Call-A-Bus demonstration was originally conducted with UMTA Section 6 (Service Development) funds and has been evaluated by the SMD Program. The project was designed to provide demand-responsive transportation for elderly and disabled persons for whom use of regular public transit was difficult or impossible. Coordination with local social service agencies in providing transportation services was emphasized. The local public transportation agency operated the service.

Call-A-Bus service was originally provided on a daily basis to the City of Syracuse and surrounding Onondaga County, an area of 794 square miles. Only four buses were employed in the service. The large area made it difficult to provide efficient service with the small vehicle fleet. Further, a demand study showed that most Call-A-Bus trips did not leave Syracuse or its immediate suburbs. Consequently, daily service was subsequently restricted to Syracuse and surrounding suburbs and the remainder of the county was divided into five sectors, each being served on a one day per week basis. Group trips of 15 or more persons were accommodated on any day subject to vehicle availability.

Prior to the demonstration, transportation services available to the handicapped and elderly consisted of a 46-route existing bus system, and a network of 14 agencies operating some 30 vehicles. Four agencies also occasionally contracted taxi service for their clients. The agency services were believed specific to agency functions. A survey of the regular transit system showed 15% of its riders to be aged 65 or over.

Due to the large service area, a two-day advance reservation requirement was established so that bus trips could be scheduled more efficiently. Subscription door-to-door services were also available as an alternative to call-in. Fares for call-in and subscription demand-responsive

TABLE 5. TIMING OF DEMONSTRATIONS

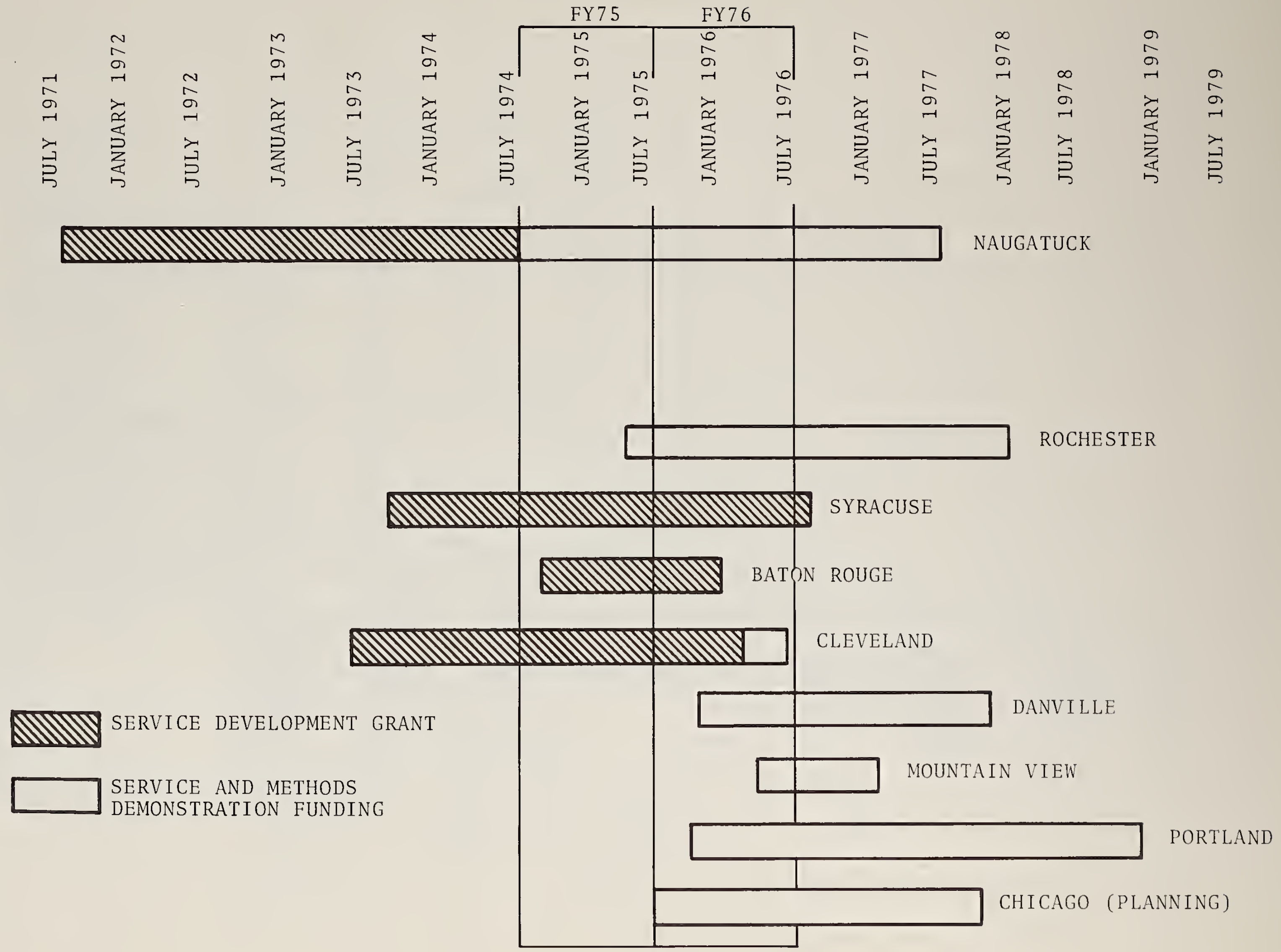

TABLE 6. OVERVIEW OF DEMONSTRATION DESIGNS

	Valley Transit District, Naugatuck, Conn.	Call-A-Bus, Syracuse, New York	Special Transportation Services Baton Rouge, Louisiana	RITD Rochester, New York	Neighborhood Elderly Transportation Services, Cleveland, Ohio	Taxi Discount Demonstration Danville, Illinois	Community Services Cooperative, Mountain View, California	Handicapped and Elderly Transportation Program, Portland, Oregon	Special Transit Service for Mobility Limited, Chicago, Illinois
Project Status	Operational	Demonstration completed	Demonstration completed	Operational	Demonstration completed	Operational	Operational	Operational in FY 77	Operational in FY 77
Transit Service Area (sq mi)	59[1]	794[2]	88	15	8	13	NA	89	NA
Target Population	7,100	60,500[3] 25,400[4]	18,300	5,050	17,000	7,500	320	76,000	13,600
Target Population Density (per sq mi)	120	76[3] 725[4]	208	330	2,240	581	NA	850	NA
Eligibility Requirements Elderly	65 years and over	55 years and over	65 years and over	NA	60 years and over	65 years and over	Apartment resident	NA	NA
Handicapped	All	All	All	NA	All	All	Apartment resident	NA	NA
Alternate Modes Existing Transit	Very limited	Moderate	Moderate	Limited	Extensive	None	Very limited	Extensive	Extensive
Taxi	None	Yes	Yes	NA	Yes	Yes	Yes	NA	NA
Demonstration Vehicle Fleet Size	17	4	6	27	14	33	1	15	20
Total Fleet Operations Hours/Weekday	204	56	50	105	144	NA	8	NA	NA

TABLE 6. (CONTINUED)

Operating Hours Weekdays	6:00 AM 6:00 PM	9:00 AM 5:00 PM	7:30 AM 7:00 PM	6:00 AM 8:00 PM	7:30 AM 5:30 PM	7:30 AM 10:15 PM	7:00 AM 7:00 PM	24 Hrs.	8 Hrs.
Saturday	Contract	N.A.	Group Specials	10:00 AM 6:00 PM	None	8:45 AM 7:45 PM	7:00 AM 3:30 PM	24 Hrs.	None
Sunday	None	N.A.	9:00 AM 2:00 PM	8:00 AM 4:00 PM	None	None	7:00 AM 3:30 PM	24 Hrs.	None
SERVICES Demand Responsive short notice	Yes	No	No	Yes	Yes	Yes	Yes	NA	NA
advance reservation	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	NA
Subscription	Yes	Yes	No	Yes	No	No	NA	Yes	NA
Group Charter	Yes	Yes	No	Yes	No	No	Yes	NA	NA
Fixed route with deviation	Yes	No	No	No	No	No	No	No	No
Fare Ranges Demand Responsive	$.75 to $5.00	$.50 to $1.00	Free	$.50 to $1.00	$.10	$.25 to $.50	$.29 (average)	NA	NA
Subsidy, Demand Responsive	Directly to operator	Directly to operator	Directly to operator	Directly to operator	Directly to operator	User-side	None	Directly to operator	Directly to operator
Operator	Public	Public	Public	Public	Public	Private	Private	Public	Public
Service Restrictions and Important Features	Service area zoned, Demand Responsive Service available in each zone only one day per week. System also available to segements of general public.	Demand Responsive requires 2-day advance notice. Areas outside Syracuse serviced as zones on a one day per week basis.	Medical services only. Service is free to users.	Service is also available to general public.	Service limited to within small service area.	Handicapped and elderly use same taxi vehicles as general public.	Service provided by one van and broker/driver to an apartment community.	Service restricted to those unable to use regular transportation.	Service restricted to those with demonstrated difficulty in using existing transit.
Innovations	Automated collection with remote third party billing.			Computer assisted scheduling and routing.		Testing of user-side subsidy & private operator providing service.	Testing of community broker concept.	Automated fare collection with remote third party billing.	

FOOTNOTES TO TABLE 6

[1]Because of demand saturation, demand responsive services are offered in each of 5 zones on a one day per week basis only.

[2]Official service area is 794 square mile Onandaga County. Unrestricted, daily service is provided within the Syracuse urbanized area of 35 square miles; areas outside of Syracuse fall into one of five zones, each served on only ons psecified weekday.

[3]Elderly and handicapped residing in Onandaga County.

[4]Elderly only (handicapped unknown) residing in Onandaga County.

TABLE 7. COMPARISON OF DEMONSTRATION RESULTS

	Naugatuck	Syracuse	Baton Rouge	Rochester	Cleveland	Danville	Mountain View
I. LEVEL OF SERVICE							
Vehicle Coverage:							
Sq.Mi./Vehicle	3.5	8.8	17.6	0.6	0.5	0.4	N.A.
Eligible Users/Vehicle	412	11,250	3,660	N.A.	1,417	230	160
Average Ride Time (min.)	N.A.	N.A.	N.A.	23	10.6	6.3	N.A.
Average Wait Time (min.) (difference between desired and actual arrival time)	N.A.	N.A.	20	15	24	4.0	N.A.
Average Trip Length	N.A.	4.5	3.6	2.8	1.5	2.5	N.A.
II. MARKET PENETRATION							
Number persons registered	3177[1]	No formal registration	1,830	No formal registration	N.A.	2,600	No formal registration: 160 elig.
Percent of registered who are elderly/handicapped	29[2]		100		N.A.	100	100
Percent of eligible persons registered	13,1		10		N.A.	35	
Percent of registered using system at least once	N.A.	3.5[4]	20-30		N.A.	79	36.6
III. PROFILE OF USERS							
Percent who own and/or drive automobile							
Users	N.A.	33	N.A.	64.9	12	25	40
Non-Users	N.A.	N.A.	N.A.	94.4	30	61	75

Table continued on following page.

TABLE 7. COMPARISON OF DEMONSTRATION RESULTS (CONTINUED)

	Naugatuck	Syracuse	Baton Rouge	Rochester	Cleveland	Danville	Mountain View
Percent with access to public transit							
Users	N.A.	15 percent have used public transit	N.A.	N.A.	64	No public transit System	N.A.
Non-Users	N.A.		N.A.	N.A.	57		N.A.
Percent below $5,000 annual income							
Users	N.A.	50[5]	N.A.	N.A.	26[9]	73	80
Non-Users	N.A.	N.A.	23	N.A.	16[9]	41	N.A.
IV. RIDERSHIP PATTERNS							
Average Weekly Ridership (Target)	2,600[3]	2,050[6]	N.A.	1,930[7]	2,800[8]	315[10]	137
Percent of Users using system at least once a week	N.A.	42	35	50[7]	N.A.	17	73
Percent of trips that would not be made without special service	N.A.	45	4.5	33[7]	40	43	N.A.
V. ECONOMICS							
Average Passenger Demands/ Square Mile/Weekday	89	5.4	1.7	34.3	54	8.4	N.A.
Passenger Trips/Vehicle Hour	5.9	3.4	3.0	4.5	5.7	4.5	3.4
Operating Cost/Vehicle Hour (less labor)	N.A.	$8.89	$1.96	$8.10	N.A.	N.A.	N.A.
Labor Cost/Hour	N.A.	$6.43	$8.17	$9.90	N.A.	$2.50	$5.00

Table continued on following page

TABLE 7. COMPARISON OF DEMONSTRATION RESULTS (CONTINUED)

	Naugatuck	Syracuse	Baton Rouge	Rochester	Cleveland	Danville	Mountain View
Total Operating Cost/ Vehicle Hour	\$12.21	\$15.32	\$10.13	\$18.00	\$22.00	\$5.17	\$10.03
Cost Per Passenger Trip	\$2.07	\$4.50	\$3.38	\$4.00	\$3.85	\$1.15	\$2.95
Operating Ratio (Oper. Cost/Rev.)	2.4	10.1	Free System	7.8	38.5	3	N.A.

[1] As of February 1974 when registration was discontinued due to saturation.

[2] Does not include mentally retarded, an additional 17 percent of registered users.

[3] July 1975 - June 1976

[4] Percent of Eligible persons using system at least once.

[5] Percent with annual incomes under \$3,000.

[6] Final month of demonstration for Call-A-Bus = 5205 pass. + typical summer month group services = 3000 pass.

[7] All services including elderly/handicapped, period January 1976-June 1976.

[8] Average over period April through December 1975.

[9] Percent receiving public assistance.

[10] July 1976.

service were based on trip length, $0.50 for most short trips and up to $1.00 for trips to the more remote areas of Onondaga County.

While most trips lay within the 35 square mile Syracuse area, 28 percent either began or ended somewhere within the remaining 760 square mile expanse of Onondaga County. The broad coverage necessitated a serious compromise in the level of service offered. The effect of the large service area requirement is evident in an average passenger trip length of 4.5 miles, and a relatively low productivity of 3.4 persons per vehicle hour. As a result of the low system productivity, the cost of providing this service was $4.50 per passenger trip, the highest of all demonstrations.

The system did not require user registration, though service was restricted to persons demonstrating elderly or handicapped status at the time of use. As an alternative measure of market penetration it can be noted that 7.4 percent, or 2,100 persons among those estimated to be eligible have used the service at least once. Ridership on regular Call-A-Bus service grew slowly through the demonstration from about 3,000 per month after four months to 5,205 passengers carried in the final month. In addition, group ridership averaged 3,000 per month during the three summer months. Persons using the system at least once per week comprised 42 percent of these users, indicating that in spite of apparently low levels of service, Call-A-Bus was a regular alternative for many users. Perhaps due to the level of service deficiency, many who used the system were among the more dependent individuals. Sixty-seven percent of users either did not own or did not operate an automobile, 85 percent had been unable to use public transit, and 50 percent had annual incomes below $3,000.

The service accomplished substantial improvements in mobility among these highly independent users, as reflected by latent demand. Forty-five percent of an onboard survey of trips taken would not have been made without Call-A-Bus. A larger mail survey of system users also indicated that 16 percent of Call-A-Bus trips would not have been made by any other mode. Those who traveled by Call-A-Bus rated the service as excellent, and reported dissatisfaction only with availability on short notice and convenience of making return trips.

Call-A-Bus demonstration funding ended in October 1975. However, Call-A-Bus is being continued as part of the

regular transportation service of the local public transportation agency, CNY Centro, Inc.

Baton Rouge, Louisiana - Special Transportation Services Project

The Special Transportation Services (STS) Project in Baton Rouge was conducted under an UMTA Service Development (Section 6) Grant to assess the performance of a special door-to-door service specifically to meet the medically related needs of the elderly and handicapped. STS was provided through the Capitol Transportation Corporation, the existing public transit operator in the region. However, the STS service was operated as a division separate from the conventional public transit service and was not coordinated with existing transit routes.

The area over which STS operated comprised about 88 square miles, representing a potential demand of 18,300 elderly and handicapped. Before STS, transportation alternatives available to the elderly/handicapped consisted of fixed route transit service, some level of taxi service, and services provided by various social service agencies. Whereas the existing transit system was relatively inexpensive at $0.15 per ride, no easy routing to medical destinations existed, and users faced particularly difficult access and egress problems. Taxi services were used, but very infrequently, due chiefly to high cost. Social service agency transportation was difficult to use since vehicle availability was uncertain. Hence most of the people serviced by STS relied heavily on the private autos of friends and relatives to access medical services.

The fleet of six extensively modified vans, five of which were in service at any one time, provided prescheduled pickup and delivery services without charge for those with medical needs. Trips were arranged through a central dispatcher who received phoned-trip requests from pre-screened and eligible users at least one day in advance. In the face of scheduling conflicts, STS staff would attempt to rearrange appointments with doctors in order to service as many people as possible.

Because STS was designed to serve only medically-related travel needs, its results should be regarded differently from other demonstrations. Restrictions imposed by purpose and a small vehicle fleet serving a very large area required one-day advance notice for trip requests.

The impact of the Baton Rouge system in penetrating the market was limited by the restriction of travel for medical purposes only. A total of 1,830 persons registered for the service. This was only 10 percent of the eligible population of elderly and handicapped, in spite of the fact that the service was free.

There is evidence that, for those who were users, STS has had a profound impact on both lessening dependence on others and improving delivery of medical services in Baton Rouge. Fifty percent of system users did not have an auto alternative for the trip, and use of existing transit service for these activities was difficult for most. Thirty-five percent of the users relied on the service at least once a week, and 90 percent have rated it as good or excellent. Thirteen percent of clients using the service required wheelchairs. Also, persons of lower socio-economic status provided proportionately greater numbers of riders on the system. Numerous medical facilities have commented favorably on STS, and cancellations in at least one major clinic declined by 60 to 70 percent during the first year of operation. Very few new trips, less than five percent, appear to have been generated by the service, hence mobility gains can only be classed as slight. Because of the purpose restriction, it is reasonable to conclude that most of the trips on STS were of an essential nature and would have somehow been made, though perhaps at greater cost to the user.

The trip purpose restriction, fleet size, and broad coverage were also responsible for a low productivity of three passengers per vehicle hour on STS. However, in spite of the inherently low productivities, average operating costs for the final four months of the demonstration period were $3.40 per passenger trip. This proved comparable to local taxis which would have cost $3.00 for a 3-2/3 mile trip, the average STS user trip length.

The STS demonstration officially concluded in December 1975. The current service, under assistance from HEW, is operationally the same as that offered during the UMTA phase. HEW eligibility requirements have restricted the use by some former riders, however.

Cleveland, Ohio - Neighborhood Elderly Transportation

The Cleveland Neighborhood Elderly Transportation Project (NET) was funded jointly by an UMTA Service and Methods grant and the HEW social and Rehabilitation Service,

Special Transportation Services (STS) for the Elderly & Handicapped in Baton Rouge, Louisiana

Dispatcher Coordinating Immediate and Advance Reservation Demand-Responsive Services in Cleveland, Ohio

with considerable local assistance. The project was designed to meet the travel needs of elderly and handicapped living within three high-density inner-city demonstration neighborhoods. The experiment was also structured to test the feasibility of a public transit system providing specialized services as part of its everyday operations.

The Cleveland service area consisted of three distinct low income neighborhoods: Buckeye, Model Cities, and Tremont. The three neighborhoods contain sufficient activity centers and services to satisfy most of the basic daily needs of elderly residents. Additionally, an Areawide Model Project on Aging was working to improve the service delivery systems in these areas; NET service was confined to these areas to permit testing of the efficacy of these service developments. A fleet of 12 Airstream "Argosy" buses and two Dodge "Maxivans" equipped with wheelchair equipment provided immediate and advance reservation demand-responsive services that differed measurably from the existing fixed-route concept. Elderly and handicapped clients and their assistants were carried for a fixed fare of $0.10 each. In terms of the basic service model, the Cleveland system is typical of a small service area with a very high density of elderly and handicapped and a relatively large fleet.

Demonstration funds for NET officially expired on March 31, 1976, at which time NET operations were taken over by the Cleveland Regional Transit Administration. The results of the demonstration have resulted in a set of policy recommendations by RTA to expand the NET-like services into a larger program of Community-Responsive Transit (CRT) that would serve other portions of Cleveland and Cuyahoga County.

Prior to NET, neighborhood residents had access to an extensive fixed-route transit system. Three-fourths of NET users reported that they were physically able to use the existing CRT service. The CRT and NET fares were both $0.10 per ride, though CRT was free to users in the offpeak. However, the immediate and advance reservation demand-responsive door-to-door services of NET offered measurable improvement in overall level of service from the CRT fixed-route concept.

The data on Cleveland's user registration is not available, but ridership was relatively high in comparison with the other projects. Cleveland's 2,700 average riders per week is the highest of all demonstrations though NET offers neither service to the general public nor group charter services.

Part of the explanation for this high level of ridership lies in the lack of private alternative modes for many of the users. Only 12 percent of NET riders claimed to own or drive an automobile, and no more than 33 percent had an auto available. It is significant to note that three-fourths of the users reported that they were physically able to use the existing rather extensive fixed-route transit system. Given the service improvement of NET over CRT, it is not surprising that the largest mode shift with this set of alternatives was from existing bus service to the demand-responsive service.

The Cleveland system is responsible for a number of trips that were not being made before. An estimated 40 percent of trips on NET reflect latent demand and improved mobility. While NET was not reaching the most severely in need, and many of its users were drawn away from the extensive existing transit network, a survey of 100 NET users has indicated that most of these individuals were of relatively low income and were now making more trips to more desirable destinations at lower cost than they were able to realize before. In the same survey, users identified door-to-door service, special driver assistance, low fares, ease of boarding and deboarding, and assurance of personal safety as important features of this type of service that encouraged its use.

The cost of supplying the service in Cleveland was considerably more than the other projects: $22.00 per vehicle hour. This is offset somewhat by a relatively high productivity of 5.7 trips per hour; however, cost per trip of $3.85 was still one of the highest experienced.

Naugatuck, Connecticut - Valley Transit District

The current Naugatuck demonstration of community service with emphasis on the transit dependent, funded through the Service and Methods Demonstration program, grew from an earlier study to improve service to the elderly and handicapped sponsored by UMTA beginning in July 1971. In addition to the guiding SMD transit dependent program objective, this project has developed methods for providing effective and coordinated service to health and social service agencies, has tested the use of an automated credit-card billing system, and has recently employed service concepts that encourage general public use of the system to boost productivity.

Bus Equipped with a Special Lowered Step to Assist Elderly and Slightly Handicapped in Boarding and Leaving the Bus, Naugatuck Valley, Connecticut

The Naugatuck Valley Transit District (VTD) serves Shelton, Ansonia, Seymour and Derby, Connecticut, a combined area of about 59 square miles with a total population of 75,000 and an elderly and handicapped population of 7,100. Available transportation before the demonstration consisted of a single fixed-route bus line in each of the four communities and a taxi service operating between the business districts of Ansonia, Derby, and Shelton. The demonstration system has used a fleet of 17 vehicles (10 vehicles are usually in service) to provide demand-responsive service with limited deviation, contract bus service for social service agencies and other groups in the valley. A subscription service is available to the general public, focusing on specific purposes, such as work and school trips to achieve high productivities. In terms of the basic service model, Naugatuck is categorized as a large transit service area with a low residential density of eligible ridership, and a medium-sized vehicle fleet.

The group charter or rent-a-bus service at VTD is the predominant type of service to date, accounting for two-thirds of all trips and 50 percent of total vehicle hours. The group service is essentially many-to-one, and can be obtained by social and health service agencies as a regular weekday service. Other groups can charter the buses at the end of the normal operating day and on the weekend, thus maximizing fleet utilization. The demand-responsive and subscription services of VTD are furnished by a 10-vehicle segment of the fleet, the remainder being assigned to charter services. The conflict in vehicle demand, as well as the problem of a large service areas, caused demand services to be made available in only one of five zones on a given day of the week, although on these days only a two-hour advance reservation is required. While the subscription service is a many-to-many service, demand-responsive service is constrained to few-to-many to make maximum use of vehicles. Fares for demand-responsive service range from $0.75 to $5.00, while costs of group service are shared evenly between VTD and the sponsoring agency. All scheduling and dispatching functions are manual.

An interesting and innovative feature of the Naugatuck demonstration has been the introduction of an automated fare collection system, which uses credit cards and monthly billings to eliminate the need for cash payment at the time of use. The system facilitates computation of the fare which is based on a zone fare structure. Fare subsidization of agency-sponsored handicapped and elderly citizens is facilitated by a computerized system which bills sponsoring

agencies according to use of the service by their clients during the previous billing period. The trip records used in computing charges also provide the operator with important feedback information on the characteristics and travel patterns of the clientele.

The Naugatuck VTD system has had relatively limited equipment and operating funds for its rather extensive service area. This has resulted in management policies which encouraged group charter services and limited the level of service provided on the demand-responsive mode. The service is available only on a once-a-week basis in a given sector of the community and only with advance reservation.

VTD had officially registered 3,177 persons, including 1,200 persons who were not elderly or handicappped, when it became necessary to suspend registrations due to system saturation. The registered handicapped and elderly citizens represent a penetration rate of about 13 percent of the total market, but it must be recognized that the supply shortage constrained the potential penetration rate.

During the period July 1975 to June 1976 VTD carried an average of 2,800 passengers per week, 2,600 of which were elderly or handicapped. About two-thirds of these trips were made through the group charter service, and were principally trips related to social service agency functions. This was in contrast to the subscription service, which principally filled worktrip demands, or the demand and fixed-route services which tended to serve a variety of purposes. The dominance of the group charter service is evident, however, with 36 percent of all trips related to social service activities. Data does not exist at this time that would permit estimation of the mobility improvements brought about by the VTD service.

Regarding the institutional aspects, VTD has been involved with and made progress in the area of coordinating social agency transportation. By setting an example with effective service, VTD has been able to consolidate the needs of these organizations into a more centralized program. At least eleven agencies now contract VTD service on a regular weekly basis. Agencies have seen it wise to contribute to VTD rather than invest in their own fleets. The HEW grants that these agencies command are used instead to drive a program that resembles the user-side subsidy concept.

In spite of the large service area, the VTD system is realizing an overall productivity of 5.9 passengers per vehicle hour for all services. This is largely due to the dominance of charter services, which achieve productivities sometime reaching 20 passengers per hour. The high productivity results in an average cost over all services of $2.07 per passenger trip and an operating ratio (cost to revenue) of 2.4, the lowest of all demonstrations for which there is operating data.

Rochester, New York - RITD

The Rochester demonstration bears some similarity to the Naugatuck demonstration. Whereas in Naugatuck the system has evolved from a major emphasis on serving the trasnsit dependent with a portion of the riders consisting of the general public, Rochester is an example of the provision of specialized services to the elderly and handicapped within a system that is primarily intended to serve the general public. The Rochester demonstration is discussed in Chapter 2. In addition to testing service improvements for the elderly and handicapped, this project demonstrates techniques for connecting dial-a-ride service within Rochester suburbs (Greece and Irondequoit) to fixed-route service to downtown Rochester. The elderly and handicapped ride with the general public, and wheelchair service requests are noted to insure that a lift-equipped vehicle is dispatched. Elderly riders are encouraged to use the demand-responsive services, particularly in the offpeak when fares change from $1.00 to $0.50 per ride. Additional savings can be made through group riding, with each additional member in the party paying only $0.25. Handicapped services fall in the same service category as elderly, but have the additional liberty of traveling to a dozen destinations outside the service area at $2.00 per ride. Group trips are growing in popularity, though they have been one-to-one services. Fares vary with the service arrangements, and in some cases third parties, i.e., stores or shopping centers, subsidize part of the cost of this service.

Since RITD serves the general public, no formal registration was required, and the extent of market penetration among the elderly and handicapped is unknown. About 10 percent of the total ridership are aged 65 or over, which is greater than the elderly population percentage for the service area. Demand for the special handicapped advance reservation service fluctuates widely from no trips in a week to significant ridership, usually as a result of

handicapped group travel. Special handicapped ridership is generally less than 1 percent of the total. Charter services from elderly housing complexes to shopping centers have the highest vehicle productivities (above 20 passengers/vehicle hour) and account for about 5 percent of the total system ridership.

Mountain View, California - Community Services Cooperative

In an SMD project nearing completion in Mountain View, the concept of a "community broker" is being tested as a way of providing improved service to the elderly and handicapped. The community broker for the Community Services Cooperative functions as an intermediary between the travel demands of a community of elderly and handicapped citizens and a system of transportation services consisting of either standard five-passenger taxis or an eleven-passenger van. Since the full fare for even short taxi trips exceeded $2.50, even full-occupancy ride-sharing did not produce costs that were low enough to make taxi desirable. Thus most travel requests are being served with the van, whose higher occupancies produced acceptable levels of cost per ride. The broker (who drives the van) is responsible for organizing trips to shopping centers, churches, etc., on a pre-scheduled, shared-ride basis. As the number of passengers increases, the fare per person is reduced. No subsidy mechanism is involved, and variability of this concept depends on whether travel demand produces sufficient revenues to cover the cost of the broker and administrative costs of the cooperative.

The initial site served by the broker and van was an elderly citizen apartment complex with approximately 160 residents, all eligible for the service. The van service has already expanded to a second such complex one mile away. A further expansion is underway to provide service to the neighborhoods which are contiguous to the two complexes as a way of establishing the necessary ridership base.

No firm conclusions can be drawn as yet regarding the economic viability of the community broker concept. It is estimated, however, that the operation will reach the breakeven point when the total number of registered clientele reaches about 300 (it is currently at 110), the number of one-way trips per vehicle averages 24 per day (versus 5 at present), and the average number of riders per trip reaches 7.5 (presently 5.5). These levels of use should produce revenues of about $360 per week, enough to support the broker and van service.

Community Services Cooperative Providing
Shared-Ride, Pre-Scheduled Van Service to
Shopping Center in Mountain View, California

Seventy-three percent of all riders are frequent users. Many of the trips, e.g., to shopping centers, have become regular with fairly consistent occupancy rates. Users have indicated satisfaction with the dependability of the service and the assistance offered by the broker/driver. Increasing the membership in the cooperative has been a slow process due to the newness of the concept and the lack of prior experience with this type of service within this eligible group. Considerable effort is going into developing effective techniques for communication, arranging schedules, determining travel needs, and developing the most productive trips.

Danville, Illinois - Taxi Discount Demonstration Project

An ongoing demonstration in Danville is testing the capacity of a private taxi system to meet the specialized transportation needs of elderly and handicapped citizens. The experiment is one of the more recent and more innovative Service and Methods Demonstration projects. In addition to the use of private taxis as the supply system, the project incorporates a user-side subsidy strategy with discount fares for eligible riders.

The Community of Danville is somewhat unique among demonstration sites in that there were no existing public transit services. Aside from private auto, the major alternative transportation choice to the Danville resident is the taxi. Taxi services were, at the beginning of the demonstration, supplied by three independent companies with a vehicle fleet of about 33 cabs. Additionally, eleven social service agencies provided some paratransit services to a fairly large clientele (3,000 passenger trips/week) which included an equal number of children and elderly/handicapped. These agencies operate a total of 11 vehicles (8 autos and 3 vans), and service only trips related to the agency programs. Hence, the broader travel needs associated with shopping, business and other social/recreational purposes were served either by private auto or taxi.

The regulatory structure in Danville controls the level of taxi fares and has supported group and shared-riding practices since 1974. The shared-ride service is a many-to-many demand-responsive arrangement, with separate fares charged each individual, but with the effect of increasing vehicle availability. The group ride is also demand-responsive, providing one-to-one service for groups of two or more. In these cases, the fare is split among occupants,

with a $0.15 incremental charge per added person. The taxis in Danville base fares on a system of five zones within the city, and for destinations outside the zone system fares are levied on additional mileage. Additional charges may also be made for the carrying of packages or unreasonable wait times for the operator.

The user-side subsidy to the elderly or handicapped user in effect discounts the cost of the ride by an amount of 70 to 75%. This results in an average fare per ride of generally $0.25 to $0.50. Incremental charges for ride-sharing passengers and other charges are discountable at the same rate. Users are permitted to make discounted trips up to a monthly budget limit of $20.00. The rider pays the discounted amount of the fare at the time of the trip. The remainder of the fare is recorded against their registration number on a "charge slip" from which the taxi operator bills the third or subsidizing party.

The Danville Taxi user-side subsidy experiment offers the highest level of service of all demonstration systems. The fleet of 33 taxi vehicles, operating over a service area of only 13 square miles, produced a maximum vehicle coverage rate of more than two vehicles per square mile. While the general public competes for service from this system, and in fact accounts for over 70 percent of all trips, these uses tend to be greatest for work trips during the peak hours. Independent of what the offpeak use requirements of the general public might be, elderly or handicapped users wait an average of only about 4 minutes for a trip request to be filled. The time spent riding in the cab then averages 6.3 minutes, which is relatively low for an average trip length of 2.5 miles.

After eight months of project operation, 2,600 elderly and handicappped eligibles had registered for the service, or 35 percent of the total eligible population. Of these, 2,050 or 80 percent, used the service at least once. Regular ridership, however, has not been strong. For a month of average demand, weekly ridership was only about 315. It has been determined that 17 percent of project users make trips at least once a week. Only about one-fourth of all users own or drive an auto, and an additional one-third depend on others for rides. The system is clearly reaching, at least in terms of registrations, the more transit dependent segments of the eligible population. The registered group has significantly fewer transportation alternatives and significantly less household income than those who have not registered. The mobility of those using the system appears to have improved; almost all users have

rated the service as good or excellent. Forty-three percent of trips taken would not have been taken otherwise.

The project has not elicited the ridership that might have been expected for a low-cost, high quality service. While the monthly subsidy budget limit would, on the average, allow 15 one-way person trips per month, median use is now only four trips. Circumstances and seasonal demand effects may have a bearing on this anomaly. A major disruption occurred when the second largest cab company left the market, causing about a 1/3 loss in capacity. Expansion by the other firms made up some but not all of this loss, and the event clearly had some impact on service and demand. Fourteen percent of registered users reported problems with prompt availability. Other possible factors in the delayed acceptance may be the high rates of auto availability among non-users and various difficulties, real or perceived, in using cabs or the subsidy programs. Some persons have not signed up for the service owing to physical problems in using cabs. There is also little social service activity in this community that is not already being serviced through the private fleets of agencies. Another problem may have been registration itself; 42 percent of those registered encountered problems in signing up.

Perhaps the most significant aspect of the experience to date on the user subsidy concept applied to shared taxi trips is the cost effectiveness of this type of service. Taxis are proving to be a viable mode for shared-ride travel, both in terms of cost/trip and level of service provided. The economics of the service are considerably better than the other projects. Taxis are realizing productivity levels of 4.5 passenger trips/vehicle hour over all services, which is high considering their five-passenger capacity. The average cost per passenger trip, including administrative costs, is $1.15. The taxi operator also reports satisfaction in serving the demands of the subsidized users, since the subsidized trips meet the standard fare. The demonstration has made it clear that taxis with user subsidy offer great potential, but that more needs to be learned about the concept before its impacts and applicability are sufficiently understood.

Portland, Oregon - Handicapped and Elderly Transportation Project

The Portland Handicapped and Elderly Transportation project is scheduled to begin service in December 1976. It will in many ways replicate the transit service model and

Control Center Coordinating Door-to-Door Service for Elderly and Handicapped in Portland, Oregon

Wheelchair Lift Equipped Bus Serving the Handicapped and Elderly, Portland, Oregon

techniques that have proven effective in the Naugatuck demonstration. It will test the applicability of this type of service in a medium-sized urban area, incorporating a range of demand-responsive services to meet the special travel needs of the transportation handicapped. The public transit authority will provide the service and contract with social service agencies to transport their clients. The Portland demonstration will use the automated credit card fare recording and billing system pioneered in Naugatuck that permits third party billing where user costs are assumed by agencies.

The project will provide special transportation services to an eligible segment of the estimated 76,000 elderly and handicapped population residing within the 89 square mile city limits of Portland. Service will be available to those elderly and handicapped who are physically or mentally unable to use the regular city-wide fixed-route system. The fleet of fifteen small buses will supply advance reservation demand-responsive and subscription services to this region. Three of the vehicles are equipped to service wheelchair passengers. The fares for agency clients will be $3.00 per trip. Eligible users not affiliated with an agency will pay $0.50 per trip. Private taxi operators will be under contract to service those trips which cannot be supplied productively by the bus system.

A pre-demonstration survey was conducted to develop data on the size of the transit handicapped population and on their travel needs and type of disabilities. These data are being published for use by other communities involved in designing service for the transportation handicapped. Using a functional definition of the handicapped, it was determined that 5.5% of Portland citizens are transportationally handicapped. This number is evenly divided between those who are severely handicapped and those who are moderately handicapped. The disability incidence among elderly persons 65 years and over is 27.5 percent.

<u>Chicago, Illinois - Special Transit Service Project for the Mobility-Limited</u>

The Chicago demonstration is planned to develop a "big city" model for the provision of specialized transportation services to handicapped and elderly persons. A demonstration planning project is now in progress to develop an approach to meeting the mobility needs of those Chicago residents who cannot use the existing fixed-route bus and

rapid transit system. Two elements are being focused upon in this planning phase: coordination of existing transportation services, and development of an institutional structure to "broker" or actually provide additional service to those not now being served. Efforts included under coordination have resulted in complete inventory and survey of all specialized providers of transportation in the City of Chicago, and a directory for use by consumers which contains a listing of each transportation provider, service types, fares, equipment, user restrictions, etc. Potential areas of coordination among these providers are being addressed.

The service options including either or both public and private providers are being analyzed, with special attention being given to the provision of work trips for those handicapped persons unable to use the current public transit system.

Concurrent with this effort, a citywide needs assessment of the transportationally handicapped is being conducted, with detailed surveys being taken in the proposed pilot demonstration area.

IMPLICATIONS OF RESULTS

Level of Service and Cost

SMD demonstrations have tested a number of important service concepts with a variety of travel environments and with differing supply capabilities. These will enable a study of how the level of service and costs vary from site to site and to identify the factors which cause the variations. These relationships are useful in planning future services which will provide appropriate levels of service in a way that maximizes productivity from the available resources in a given market.

Relationships Between Service Area Size, Productivity, and Cost

The size of the service area is a basic determinant of achievable productivity and cost. Other things being equal, such as vehicle coverage rates and population density, the larger the area serviced the more the trip requests are dispersed. Larger service boundaries also generally imply a greater number and spatial distribution of destinations. Door-to-door demand-responsive services in particular rely

heavily on concentration of travel requests in space and time to achieve productivity. Concentration of travel requests become more difficult with increasing area size. Syracuse Call-A-Bus, for example, served a market area of 794 square miles and was able to achieve productivities of 3.4 passengers per vehicle hour. This productivity would have been even lower had they not instituted the sector service policy, i.e., daily service to a core area and trips to a different sector of the outlying area each day. Cleveland, in contrast, serviced an area of only 8 square miles, and averaged productivity of 5.7 passengers per vehicle hour.

Density of Target Market in Service Area

Density of the eligible service area population has an important impact on level of service policies and productivity. If eligibility criteria define a market with a low density of users, it becomes difficult to aggregate and fill trip demands efficiently with policies that provide the higher levels of service. Naugatuck and Rochester, both suburban areas with low densities of eligible users, have combined services for the elderly and handicapped within a framework of service to the general public. An integrated service strengthens the demand base and the productivity of the demand-responsive services.

Improved Productivity through Travel Grouping

When the problem of service area size makes it difficult to service scattered demands efficiently with the available resources, different service concepts or policies can be employed to reduce the randomness and dispersion of demand. These concepts are essentially restricted versions of the immediate response, "dial-a-ride" concept and can reduce the service to a level manageable by the system without destroying the door-to-door feature of the specialized service, perhaps its most important attribute. Level of service may in fact improve under some of these restrictive concepts, since delivery of the service becomes more predictable to the user and more efficient to the provider. The available policy options to deal with the problem of a large service area are:

- <u>Charter Trips</u>

Several demonstrations have made successful use of this concept in which a single vehicle is dispatched to

carry a group of generally ten or more people from a few origins to a single destination. These services are productive by their very nature. Naugatuck, Syracuse, and Rochester have employed charter services for this purpose. At Naugatuck, two-thirds of all trips are made by group charter; productivities for these services have at times reached 20 passengers per hour. This service has been the principal reason for Naugatuck's high system productivity despite a service region that is large relative to available resources.

- Advance Reservation

By requiring the user to inform the system of his travel need through some advance notice, system operators can aggregate trip demands over place and time and arrange rides with higher productivities. This concept was the way by which small capacity systems like Syracuse and Baton Rouge were able to provide some form of demand-responsive service to a very large service area. Subscription service for regular trips is an important form of advance reservation policy.

- Service Area Segmentation

A policy that can make a large service area manageable is to partition the area into a core area with daily service and outlying zones that are served at different days of the week. This allows concentration of both fleet and trip demands over a smaller area. Both Naugatuck and Syracuse used this policy to advantage in building productivity into their demand-responsive services.

- Brokering

When private operators are the source of supply, efficiency can be attained by establishing a broker to coordinate trip demands with service supply. The broker can organize individual requests into group rides to make maximum use of available vehicles while making the service more attractive to users by lower fares through ride-sharing.

- Agency Coordination

Coordinating the transportation needs and programs of medical and social agencies who deliver services to the transit dependent through a multitude of private

transportation resources may improve the efficiency of the transit operator and permit more productive use of the travel budgets of these agencies. Naugatuck VTD has been able to accomplish such coordination and Portland is pursuing agency contracts as the primary source of revenue for their special service. The results of this approach are seen in both extensive group charter service contracted by agencies and agency investment in the public system rather than their own fleets.

Other Factors Affecting Cost of Service

Even though service area size, population density, and service policies are the major determinants of level of service and cost of supply, several other factors must be considered:

- Vehicle Size

Cost of service is also a function of the type and size of the vehicles used. Required vehicle size is determined by the type of service, demand, and demand density. Larger vehicles must obtain higher productivities (passengers/vehicle-hour) to support their higher cost. Consequently, a productivity of 4.5 for the taxi vehicles in Danville is more cost-efficient than the same productivity achieved with larger vehicles operating with considerable unused capacity.

- Operating Cost Differentials

Site-specific cost structures must be considered along with productivity when judging whether service costs per passenger are reasonable. For example, cost per vehicle operating hour ranged from $5 to $22 in the set of demonstration projects. Differences in vehicle size and cost account for some of the cost variations. However, labor rates are usually the most important single component of operating cost. Transit systems, often publicly provided, are subject to the operating agreements with transit labor unions, which generally include guaranteed work-hour clauses and relatively high labor rates, ranging from $6.43 to $9.90 per hour in the demonstration cases. In contrast, private taxi wage rates are much lower. Danville taxi drivers earn $2.50 per hour. The $5.00 rate at Mountain View includes a brokerage as well as a driver function.

Eligibility and Market Penetration

Demonstration experience points out that the issue of who should be served with available resources must be carefully considered. There is always the danger that overly flexible eligibility criteria may exclude the least mobile population groups. Cleveland followed a self-certification process of users and found that the more aggressive and able-bodied individuals utilized the service more often than those who in fact needed it more. This evidence suggests that if the objective is to serve the extremely handicapped or shut-in person, some form of marketing or outreach program may be needed to inform these people how to use the service. The alternative approach is to restrict service to the most needy through the certification process, but this may have a negative effect on productivity by decreasing market density. Both the Portland and Chicago demonstrations will conduct extensive user-need studies that will determine the relative needs of the population and will be used to design service and eligibility criteria to ensure adequate service for the neediest.

Because many able-bodied elderly persons can use an auto or already have adequate mobility, some means of segmentation of the total elderly and handicapped population is necessary to determine the actual penetration of the transit dependent market. This penetration is represented by the percentage of transit dependent who have registered to use the service or have become regular users. Typically, not all eligible persons will register though more will register than the number that actually ride, and more will ride one time for experimental purposes than those who become regular users. Factors affecting market penetration are listed below:

- Level of Service

  The level of service, i.e., frequency, coverage, and service hours, is obviously going to impact market penetration.

- Alternate Modes

  Market penetration is generally less in areas where the automobile is commonly available as an alternate mode. In contrast, markets where existing fixed-route transit is the principal alternative have had higher rates of penetration.

- Income

Market penetration is generally higher in areas with lower household incomes. Persons from these households seldom have automobile alternatives and are willing to accept even poor levels of service if it means making or not making the trip. Relatively high penetration in Syracuse, Baton Rouge, and Cleveland was based on this factor.

- Promotion and Outreach

Promotional efforts should improve market penetration. Few of these demonstrations are engaged in substantial promotions, however, so the eventual impact on market penetration is not clear. Registrations at Naugatuck grew to a saturation level without promotion. Cleveland and Mountain View were the only projects that promoted service to any great extent. In Cleveland, the service did not attract many of the hard core transit dependent. This experience points to the need for a comprehensive and continuing outreach program to reach the most needy.

- Service Saturation

In the absence of appropriate eligibility requirements, it is possible for the system resources to be saturated at a given level of demand before full penetration of the target market. Market penetration clearly depends on the physical resources and the ability of the service to accommodate all that want to use it.

User Benefits

Low tripmaking rates characteristic of the transit dependent population make it difficult to measure changes in mobility without taking data for a large portion of the eligible market. The variability of the data is often as large as the mean tripmaking rate, so it becomes difficult to make quantiative assessments regarding the extent of mobility improvement, if any. Consequently, the more feasible approach is to determine perceived improvements in mobility while measuring user attitudes toward the service.

Examining attitudes in several locations revealed that these services were very well-received by the users. Substantial numbers rated the services in their area as good or excellent, especially in comparison with their other

alternatives. Users without automobile alternatives commented on the importance of being freed from their former dependence on the availability of others to chauffeur them. Their travel is no longer restricted to those destinations and times which are possible or most convenient for the person they are riding with. Many users reported being able to make trips they could not take before the service was available. Some reported that they are able to take more trips, including many non-essential as well as essential trips.

Community Benefits

Specialized services have demonstrated important social and institutional impacts in the community. Improving access to social, health, commercial, cultural, and religious activities by the less mobile citizens in the community is an important community goal that is being served by the special transportation services. Effective delivery of health and social services is strongly dependent on the transport of clients to and from these institutions at the proper times. In most areas serviced by demonstrations, agency functions were aided by the service. Increased numbers of persons participated in programs. In one case appointment cancellations were drastically reduced by the transportation improvement. Sharing costs with the transport agency through contract service is proving an effective way for service agencies to use their available funds to transport clients without themselves becoming involved in the complex and expensive task of physically providing a transport service.

FUTURE DEMONSTRATIONS

The current set of demonstrations has contributed significantly to the knowledge of methods for serving the transportation needs of the elderly and handicapped. This knowledge will both be expanded and improved in demonstrations planned for the near future.

The process of coordinating the transportation needs and programs of social service agencies is being further developed in forthcoming demonstration projects. Determining whether agency needs can be combined into a more unified and efficient program of transportation support has not been established on a basis from which the results can be generalized. Substantial resources exist among these

institutions that perhaps could be extended to more persons if used as effectively as possible.

A project currently in the planning phase for New York City will develop a working model for meeting the transportation needs of the handicapped in a major metropolitan area. The project will coordinate the complex array of existing providers, funding mechanisms, and institutional constraints, which are typical of large cities. The planning studies are currently identifying the service area and eligible users in addition to performing an analysis of the institutional framework and evaluating equipment and dispatching techniques to be used in the service. As a possible approach to surmounting the obstacles in pooling funds or vehicles and staff in the existing network, the project is studying the institutional feasibility of a taxi/livery cooperative for providing the service. The project is being conducted by the Tri-State Regional Planning Commission and New York City's Department of City Planning.

Another similar approach will be demonstrated in FY77. In a multi-funded program involving UMTA and HEW, a special demand-responsive door-to-door transportation service will be targeted at a group of 25,000 elderly and disabled residents of Manhattan's Lower East Side. The project will be managed by a non-profit corporation staffed by rehabilitated drug addicts and offenders in close cooperation with current transportation providers and service agencies in the area. An important feature of the experimental design will be the comparison of a sample of the target population with a control group outside the service area to examine improvements in mobility and mental health that are objectives of the project service. The experiment will also measure program impacts on social service delivery agencies while comparing the cost-effectiveness of a single transportation service against the current fragmented arrangement of specialized transportation services.

Demonstration projects now being planned for Albuquerque, NM, Lawrence, MA, and Montgomery, AL, will make further tests of the user-side subsidy concept while studying the appropriate role of the private transportation provider. The project in Albuquerque will test the degree to which coordinated public and private transportation services in the same market can provide effective transportation to the elderly and handicapped. The city of Albuquerque will operate a fleet of specially equipped vans on a variable fixed-route and route deviation basis,

concentrating on the higher density subscription and group riding services. Eligible users will be able to choose between the van service or making the trip with private taxi through a user-side subsidy privilege. The project is currently in the implementation planning phase.

The Lawrence and Montgomery demonstrations will also permit the user to make choices between local transportation suppliers based on cost and level of service differences. An identification card will be issued to elderly and handicapped persons, which they can then use to purchase half-fare rides on either bus or taxi transportation services. The Lawrence fixed-route bus system is privately operated. The Montgomery area is served by a municipally-owned bus system with 22 buses operating on 16 routes. There are four large (21 to 24 vehicles each) taxi companies and several smaller operators. The subsidy card will allow the user to ride the bus service at $0.15 for an unlimited number of rides or to purchase up to $20 worth of discountable taxi trips per month. The current average taxi fare is about $1.65 per trip. The Montgomery project is planning an intensive marketing campaign prior to start-up of the service.

In addressing the need to make existing fixed-route transit more accessible to the elderly and handicapped, the SMD Program is examining techniques for providing wheelchair lift equipped, full sized bus services. This effort involves evaluation of locally initiated services and an SMD demonstration of fully accessible vehicle operations.

Several cities have implemented or are planning to implement service with a portion of the bus fleet equipped with level entry mechanisms and other modifications. San Diego, CA, Atlanta, GA, St. Louis, MO, Los Angeles, CA, and Santa Clara County, CA, have been identified as potential sites in which to gather data that can be used in structuring a demonstration project. Effects such as mechanical reliability, impacts on labor, work rules, maintenance and operating cost, equipment deployment strategies, and extent of use by the handicapped will be studied.

A demonstration design will take into account the lessons learned in these cities and examine alternative strategies for using retrofitted or factory installed lift vehicles, such as (1) total fixed-route fleet accessibility, (2) an intermix of service with accessible vehicles on selected routes and/or running at intervals on routes with

non-accessible vehicles, and (3) demand-responsive feeder service to accessible vehicles on the fixed-routes.

Also in the coming year the SMD Program will begin to study the mobility problems and travel desires of other classes of transit dependents. SMD is sponsoring a study on the transportation needs of the residents of inner cities where there exist not only large concentrations of elderly and handicapped, but also the poor, the young, and the unemployed. The study will collect data on the travel requirements of inner city residents, analyze existing transportation deficiencies, and develop alternative solutions for meeting these problems. The three most promising alternatives will then be developed into site-specific demonstration project designs for later testing.

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CHAPTER 5

PROJECT EVALUATION

A crucial aspect of the Service and Methods Demonstration Program is the performance of technically sound and objective evaluations of the individual demonstration projects. Under UMTA sponsorship, the Transportation Systems Center (TSC) of the U.S. Department of Transportation conducts a broad program of demonstration evaluation, evaluation methodology development, and research in support of these activities.

The various demonstrations are intended to serve as either real-world experiments involving innovative service concepts or techniques implemented, or as exemplary models to be applied or adapted by other locales across the country. Accordingly, the focus of the evaluations is threefold: (1) to assess the institutional and operational feasibility of the demonstration concepts and techniques; (2) to assess the transportation and socioeconomic impacts of the demonstration project; and (3) to provide guidance, based on operational experience during the demonstration, for future applications of the concepts and techniques. These evaluations deal with actual events and impacts and should be differentiated from before-the-fact evaluation of potential impacts more commonly encountered in the comparison of service alternatives performed in transportation planning studies. In addition to their specific utility to the SMD Program, the demonstration evaluations also provide increased knowledge essential for improved urban transportation planning and policy formulation at all levels of government.

This chapter describes the philosophy and approach underlying SMD evaluations and discusses evaluation methodology development which is currently underway.

EVALUATION PHILOSOPHY

The SMD evaluations are structured around three basic questions:

- What changes were made to the transportation system?

- What were the impacts?

- Why did these impacts occur?

As will be explained in the following sections, these questions are addressed through careful documentation of the events and circumstances surrounding the implementation and operation of the project, as well as a detailed analysis of impacts and cause and effect relationships. Demonstration evaluations are not designed to judge the capability or performance of the grantee, nor do they emphasize classifying demonstrations as successes or failures. Rather, an important premise of the SMD Program is that every demonstration is of value if it increases knowledge about innovative transit service concepts and techniques and fosters innovation in other locales.

The SMD Program attempts to maximize the quality and utility of information gained from the demonstrations by developing and employing a consistent, carefully structured approach to demonstration evaluation. Each evaluation is built around the basic analytical framework described in the next section, and emphasis is placed on using state-of-the-art data collection and analysis techniques which are consistent from the standpoint of efficiency, accuracy, and output. This stress on consistency does not, however, preclude recognition of the unique learning potential within each demonstration. Since demonstrations vary in terms of objectives, relevant issues, complexity content, and context, the scope and emphasis of each evaluation must be tailored to the specific characteristics of the demonstration.

In view of the nature and relatively short (two to three year) time frame of SMD projects, the evaluations typically emphasize examination of short-run impacts. These primarily include impacts on users, transportation operators, and other groups which occur during the demonstration period. Only under special circumstances (e.g., a major transportation change in a large area or corridor) is there an analysis of longer-run changes such as activity shifts.

Whatever the mix of short and long-run impacts examined, strong attempts are made in the design and conduct of demonstration evaluations to monitor the presence of, and isolate the effects of, exogenous (i.e., non-demonstration-related) factors such as an economic recession, fuel shortage, or change to other parts of the transportation system. Demonstration evaluation planning generally takes place well in advance of demonstration implementation to permit measurement of key variables of interest before,

during, and after the project. In addition to the application of before-after experimental designs, evaluations often involve the monitoring of a control group or area, personnel to be affected by the demonstration, as well as the test group or area.[1] For example, the analysis of travelers' behavioral response to a new or improved transportation service typically includes non-users as well as users.

ANALYTICAL FRAMEWORK FOR SMD EVALUATIONS

The body of theory and analytical techniques which has evolved for urban transportation systems planning and analysis has largely been concerned with before-the-fact comparison of prospective transportation and socioeconomic impacts of alternative transportation systems.[2] A conceptual framework and format for evaluation has been developed which is specifically appropriate for performing evaluations of transit demonstration projects. It is designed to permit determination of cause and effect relationships and contributions of innovative elements of an operating transit system. This framework, based on principles of transportation supply and demand analysis, not only enhances the consistency and comparability of evaluations, but also permits a comprehensive assessment of project feasibility and impacts. Moreover, as will be seen, this framework is consistent in emphasis with the SMD Program objectives involving travel time, coverage, reliability, productivity, and transit dependent service.

Figure 1 depicts the basic supply-demand framework of transportation change which is being applied to SMD evaluations. The demonstration elements, no matter how many or how complex, serve to alter the characteristics of transportation supply, i.e., the number of travel options

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[1] A comprehensive discussion of various experimental design approaches can be found in Charles River Associates, Measurement of the Effects of Transportation Changes, September 1972, Chapter 4, and in Donald T. Campbell and Julian C. Stanley, Experimental and Quasi-Experimental Designs for Research.

[2] See for example, Measurement of the Effects of Transportation Changes, op. cit., Chapter 3 and Marvin Manheim, Fundamentals of Transportation Systems Analysis, 1974.

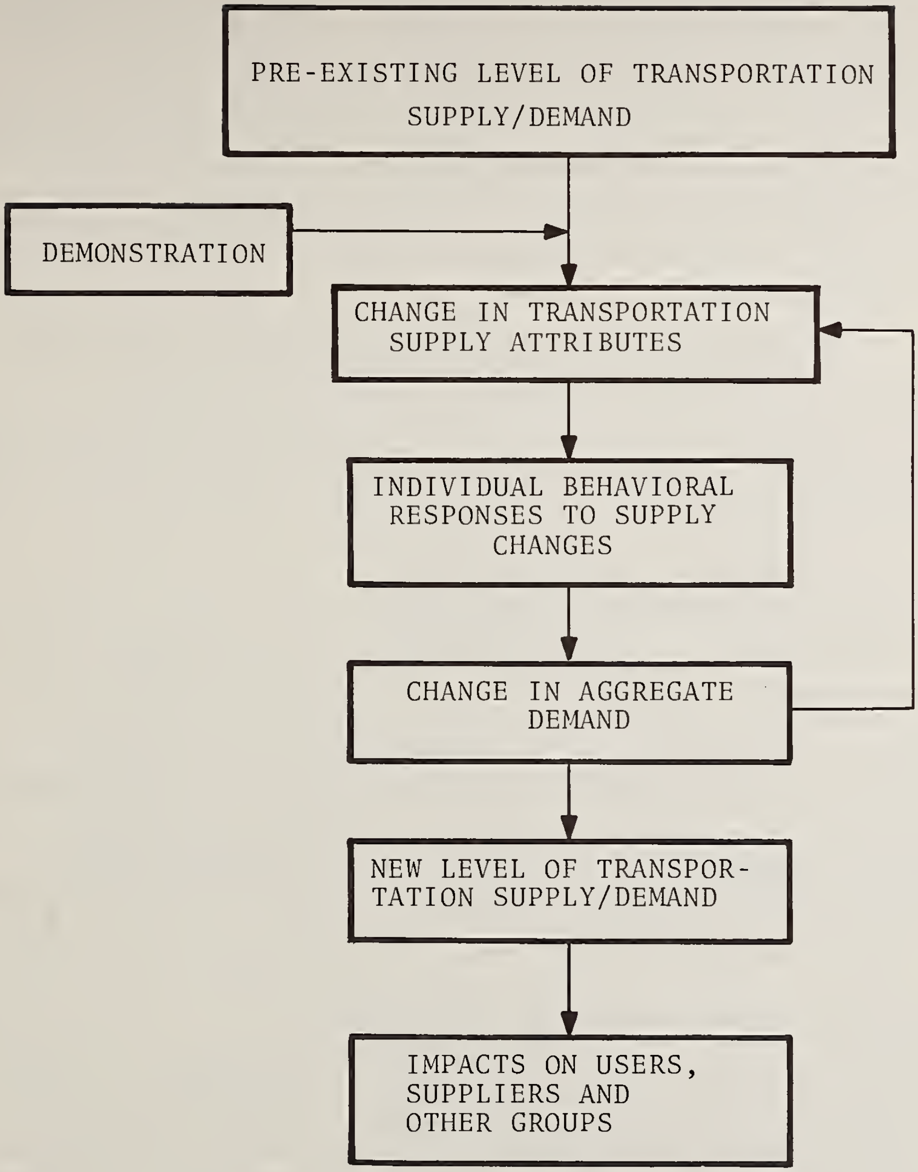

FIGURE 1. SUPPLY/DEMAND FRAME WORK FOR DEMONSTRATION EVALUATION

available and/or the level of service attributes of those options (e.g., travel time, reliability, convenience) as viewed by potential users.

In response to these supply changes, individuals make decisions regarding travel frequency (and whether to travel at all), spatial patterns of travel, mode, and time-of-day on the basis of personal preferences for these attributes. The aggregate effect of individual behavioral responses to supply changes is manifested in the level of demand for each service mode affected by the demonstration. The interaction of supply changes and demand responses produces a level of supply and demand which differs from the pre-demonstration level. The ultimate effect of the demonstration is measured in terms of impacts on users, suppliers, and other groups as appropriate.

In addition to tracing the effects of a supply-side change on demand, the conceptual framework for SMD evaluations also recognizes that because of the interdependence of supply and demand, changes in demand may affect level of service. For instance, in demand-responsive systems travel time and reliability are a function of levels of demand.

CONTENT OF DEMONSTRATION EVALUATIONS

In order to enhance the consistency of the SMD evaluations, a standardized approach for evaluations has been developed. This standardized approach involves a detailed description of the demonstration background, objectives, setting, implementation process, and operations as well as an analysis of supply and demand changes and the impact of these changes on users, suppliers, and other groups of interest. The components of demonstration evaluations are discussed below, in the order in which they would appear in a final evaluation report.

Demonstration Background and Objectives

Demonstration evaluation reports begin with a description of the significant factors and events leading up to the grant application, for instance, prior transit innovations or planning studies which underscored the need for the demonstration service concept. In addition, there is a discussion of the various local and national objectives and issues addressed by the project, which in turn form the basis for the evaluation. It should be noted that local

objectives or rationale for the demonstration do not always coincide with the SMD Program objectives or with the major issues of national importance, in that they may be related to specific problems within the site or a specific performance criterion. Thus the evaluation must be tailored to produce generalizable knowledge from the local experience.

Demonstration Setting

An understanding of the demonstration site is crucial not only for the purpose of understanding the outcome of the demonstration but also for enhancing the transferability of the demonstration. The demographic composition of the service area--for example, population density, employment density, age composition, auto ownership--may be an important determinant of the acceptance and use of the demonstration service. Moreover, it is necessary to predict the applicability of the concept for other potential sites. Similarly, the transportation characteristics of the area prior to the demonstation--i.e., supply of transportation by mode and provider, travel patterns, institutional factors--must be understood to provide a basis for comparison with the situation after the demonstration is implemented and to furnish insight into the demonstration outcome. Most important, there must be continual awareness throughout the evaluation process of exogenous changes or other site-specific factors relevant to demonstration implementation, operations, or outcome.

Demonstration Implementation and Operations

A lucid documentation of the implementation process and operations is needed to understand the viability, impacts, and transferability of the demonstration concept. This description may include preparatory steps such as personnel training and regulatory changes as well as the overall phasing and management of the project. Although reflecting site-specific conditions, the experience of the demonstration site in implementing the service can provide generally applicable guidance to other locales on possible roadblocks to implementation, steps required to overcome these obstacles, and a representative time period and resource level to allow for accomplishing these steps. The description of demonstration operations covers the services, equipment, management techniques, fares, marketing, and other innovative aspects of the demonstration. Where relevant, there is a discussion of problems encountered and

solutions adopted, which again can be useful to other sites. The SMD projects, as documented in evaluation reports, thus provide an opportunity for improving the state-of-the-art of transportation planning and transportation systems management.

There is recognition of the fact that no two locales will "activate" a particular concept or technique in the same manner. In other words, differences in implementation and operational procedures will result in a range of concept applications. Because of these subtle differences, and also because of the fact that it is useful to plan variations of a given concept or technique, the SMD Program sometimes funds several applications in order to ascertain the viability and impacts of the concept or technique under different circumstances. However, even when there is only one demonstration funded in a particular category, a key aspect of the demonstration evaluation is to carefully document the factors specific to that application--namely, project background, site characteristics, implementation process, and operations.

Level-of-Service (Supply) Changes

The analysis of level-of-service changes involves portraying in specific, quantitative terms, the effects of the demonstration project on the urban transportation system as perceived by potential users. Depending on the nature of the demonstration, one or more of the following transportation supply attributes can be affected: the choice of available modes or submodes and the level-of-service attributes of these choices such as coverage, travel time, reliability, fare, comfort, and other amenities. Current SMD projects tend to emphasize service innovations or techniques which are expected to improve coverage, travel time, and reliability--three of the five Program objectives.

Coverage is a service attribute which refers to the accessibility of travelers to the system. Spatial coverage improvements can occur as a result of transit service expansion or new service within an area not previously served by public transportation or by the replacement of a fixed-route service with a door-to-door demand-responsive service. Temporal coverage improvements can be achieved through expanded time periods of service operation or increased frequency of operation within the same time period. Because of the somewhat innovative and complex methods of increasing transit coverage applied in the SMD Program (i.e., emphasis on submodes such as paratransit

services rather than conventional fixed-route bus service), the analysis of coverage changes has required the identification of new types of quantitative measures to express coverage changes.

Travel time improvements can be made through traffic management techniques such as reserved bus lanes and operational changes involving equipment, schedules, or dispatching. Since it is known that users perceive different elements of a door-to-door trip differently, the analysis of travel time changes always entails segmentation of time savings into components such as access time, wait time, ride time, and transfer time.

Service reliability improvements may come about from some of the same techniques as result in travel time savings, as well as from specific innovations designed to reduce the variability of one or more travel time components. The analysis of reliability changes has proved to be highly complex and difficult. This is due to the lack of identifiable measures to quantify such changes, the difficulty of ascertaining which aspects of service affect reliability, and the fact that the concept of reliability varies across modes. In response to this problem, an analytical study is underway to identify an appropriate conceptual/analytical framework for dealing with reliability changes (see Chapter 7).

Over and above ascertaining the effect of a demonstration on the three SMD objectives, as relevant, the evaluations of SMD projects also examine qualitative level-of-service attributes such as safety, convenience, and vehicle amenities. Since a demonstration may improve some service attributes at the expense of others, the analysis of level-of-service changes attempts to understand the various trade-offs involved. Moreover, segmentation of measures by socioeconomic characteristics, time-of-day, trip purpose, or other means is generally performed in order to understand the differential benefits of level-of-service changes to different population groups.

Travel Behavior (Demand) Changes

In response to changes in the level of service provided by the transportation system, individuals within the service area are apt to alter their travel choices in some fashion--e.g., make a given trip by a different travel mode or in a different time period, make a given type of trip to a different destination, make additional trips. The analysis

of travel behavior changes involves measurement at the individual level and at the system level.

In terms of system level effects, it is useful to collect and analyze data continually before and throughout the demonstration on ridership, disaggregated by time-of-day, day-of-week, trip purpose, service type, and market group, as available. Moreover, aggregate statistics on market penetration (percent of eligible persons using service, with eligibility defined in terms of certain criteria), mode split (percent of trips by each mode or submode), and spatial patterns of travel (origin-destination volumes) collected at several points before and during the project, are useful indicators of the demonstration's effect on overall volume and flow of travel.

At the individual level, the analysis of travel behavior entails examination of changes in trip length, destination choice, and trip frequency, all stratified by trip purpose. In general, travel and socioeconomic characteristics and attributes of non-users as well as users are analyzed in order to isolate the effects of the transportation and to gain insight into market penetration and usage statistics. Analysis of demand elasticities are sometimes performed to understand the user's sensitivity to individual level-of-service attributes within or across modes.

Operator Impacts and Productivity

This analysis focuses on (1) the net costs of operations, (2) the utilization of vehicle capacity, and (3) the cost-effectiveness of transit services.

Cost analysis considers cost and revenue elements stratified by service type and by other factors, as appropriate. Attention is also given to recovery of costs and the impacts of operating strategies upon cost components.

Improvements in the utilization of vehicles can stem from better allocation of vehicles or from increased patronage. Analysis measures include a demand (user) element and a vehicle allocation element (e.g., passengers/vehicle hour). This set of measures is often referred to as "vehicle productivities" and is one of the five Service and Methods Demonstration objectives. Vehicle productivities are segmented by service type, and also by

vehicle type in cases where more than one vehicle is used to provide a particular service.

Improvements in the cost-effectiveness of providing service are frequently an important impact of demonstrations. Measures include a cost element and an operator element (e.g., cost/vehicle hour), usually segmented by service type and time of day. In many cases, examination of cost data can indicate that higher productivities and cost savings can be achieved by substituting a different service strategy during certain periods of the day.

Analysis of productivities and economics is not complete without consideration of factors which can explain resulting levels of productivities and efficiencies. Issues which are typically considered include management policies, driver work rules, vehicle failures, and the size of the service area.

Non-Travel Impacts

Analysis of travel behavior, productivities, and efficiency address direct impacts of the demonstration on users and operators. There are, however, broader impacts of the demonstration on these groups as well as extended effects on groups not directly involved in the demonstration services. These effects are often qualitative in nature, but are also included in the analysis.

Transit dependent groups, particularly elderly and handicapped people, experience improvements in mobility, which in turn may imply increased participation in a wider range of social activities, increased access to medical care, and an improved sense of well-being and independence from others. Similarly, the young and the poor who lack access to an automobile may experience greater educational/recreational/employment opportunities coupled with a reduction in the cost of travel and less dependence on friends and relatives. Since improved service to the transit dependent is one of the five SMD objectives, efforts are underway to devise better means of evaluating these types of benefits.

Examples of extended effects include ridership and revenue losses experienced by transportation providers other than the one(s) directly involved in the demonstration, reduced transportation costs for social service agencies formerly supplying transportation for their clients, and

economic or environmental changes affecting the community. In addition, it is sometimes relevant to view the benefits of a user's increased independence from the standpoint of the person who formerly provided the transportation. For instance, instituting an annual pass for youth may free housewives from the task of chauffeuring children and allow them opportunities to pursue part-time employment.

Summary

Once user, operator, and non-travel impacts have been analyzed in detail, there is a summary section of the evaluation report which deals with the overall feasibility and impacts of the demonstration service concept or technique. This generally includes an assessment of the degree to which demonstration objectives have been achieved (in particular, the applicable SMD objectives) and a discussion of the major evaluation issues which synthesizes findings from the preceding sections. It is important to note that in this final stage of the evaluation process, both the degree to which objectives were satisfied and the reasons for these outcomes are essential in examining the potential of the service concept and the transferability of findings.

EVALUATION PROCESS AND METHODOLOGY DEVELOPMENT

As stated above, TSC has responsibility for coordinating the evaluation planning and implementation process to foster consistency in the output of individual project evaluations. TSC's functions include: (1) establishing standardized evaluation procedures to be applied in all demonstration evaluations; (2) specifying the desired output and scope of individual evaluations and providing close technical supervision of a team of contractors who perform the evaluations; (3) developing improved methodology for demonstration evaluation; and (4) devising and implementing strategies for cross-cutting analysis of demonstrations.

The report Evaluation Guidelines for Service and Methods Demonstration Projects (Ref. 2) represents initial efforts on the part of TSC to structure the evaluation process. This document describes the basic time-sequenced process to be followed in planning and conducting an evaluation and the nature of the liaisons among the various organizations involved in the demonstration (UMTA, TSC, evaluation contractor, grantee, other local organizations).

It also contains definitions of measures to be used for level-of-service and impact assessment (with major concentration on the five SMD Program objectives), recommended data collection and analysis procedures for specific measures, and guidelines regarding survey and statistical methodology. This document is intended to undergo periodic updating to reflect actual evaluation experience and refinements in evaluation philosophy and techniques.

The demonstration evaluation process has two major components, evaluation planning and evaluation performance. In general, the planning phase begins with the preparation (usually by TSC) of an Evaluation Framework which describes (1) pertinent information on the project and its settings: (2) SMD Program and relevant national and/or local objectives addressed; (3) key questions or issues to be examined; and (4) recommended scope, focus, and approach for the evaluation. The Evaluation Framework then serves as the basis (along with the general Evaluation Guidelines) for the development of an Evaluation Plan (generally prepared by an evaluation contractor). The latter document specifies in detail the proposed evaluation design and analysis framework, data requirements, data collection methodology, analysis techniques, and technical management plan and resources necessary to evaluate the demonstration's impacts and its potential applicability to other locales.

The active phase of the evaluation involves collection and analysis of data relative to transportation and socioeconomic impacts and preparation of various types of evaluation reports. Data collection is usually performed by the demonstration grant recipient as part of the demonstration. TSC and/or an evaluation contractor is responsible for providing technical guidance to the grantee regarding data collection requirements and methodology as well as for monitoring all of the data collection activities carried out by the grant recipient. Analysis of the data, synthesis of findings for transferability, and preparation of various evaluation reports is the responsibility of TSC and the evaluation contractors. These reports and the results contained therein serve as the basis for the Service and Methods Demonstration Annual Report and are used in a vareity of cross-cutting analyses. Techniques are currently being developed and applied for comparing demonstration results across sites, both within and across demonstration service concepts. The results obtained should serve to enhance the transferability of the demonstration concepts by leading to an understanding of what factors have been most

influential on project outcome and indicating how the results would differ under other circumstances.

Owing to the technical difficulty of performing evaluations of projects which take place in real-world, dynamic settings and the absence of a ready-to-use conceptual framework or methodology for evaluation, the SMD Program provides a unique and challenging opportunity to develop and apply innovative evaluation techniques. Considerable emphasis is placed on employing the most up-to-date evaluation methodology so as to enhance the efficiency and accuracy of the evaluation process. Moreover, there is emphasis on developing and testing novel data collection and analysis techniques which have potentially broad application within the program. This methodology development occurs through formal analytical studies, which may have a broader focus than demonstration evaluation, and through informal efforts spurred by deficiencies in existing methodology.

An example of a formal analytical study geared toward evaluation methodology development is a study underway to develop better analytic techniques for measuring attitudinal responses to transportation improvements and demonstrations. This study will have two outputs: (1) a manual describing attitude measurement techniques for transportation planning and evaluation and (2) a final report containing a technical discussion of the validity and utility of attitude measurement techniques based on integration of information from a literature search, field experience, and analyses. It is expected that this study will have a two-fold impact. It will make available to transportation planners and system operators a set of attitudinal measurement techniques which can be used to evaluate responses to planned or implemented transportation innovations. Some of these techniques will be drawn from other disciplines, such as market research and sociology. This study will also validate the methodological bases of attitude measurement techniques and consider the utility of attitude measurement techniques relative to other transportation analysis procedures, thereby designating the range of applications in which these procedures are appropriate.

An illustration of more informal methodology development relates to measuring changes in mobility patterns of elderly and handicapped persons. Experience to date in evaluating transit dependent projects has revealed the difficulty of making accurate, objective assessments of such changes, owing to the inability of conventional before-after measurements to detect the expected small changes in project-induced mobility changes. As a result, research is

underway to assess the feasibility and cost of various alternative measurement strategies. As the results of this effort become available, an appropriate approach will be selected, incorporated into the Evaluation Guidelines, and then applied to ongoing and future transit dependent projects.

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CHAPTER 6

SMALL COMMUNITY TRANSIT STUDIES

INTRODUCTION

Approximately 3,800 communities in the United States have populations between 5,000 and 50,000. These cities and towns contain more than 25% of our total population. Whereas public transportation has typically been viewed in the context of large urban areas, the mobility problems of a significant portion of the population and most of the issues which form a justification for transit also exist in these smaller cities. There is a growing recognition of the need for public transit in these communities, as evidenced by new services, capital grant requests, and planning programs to assess the long-range transportation needs.

In an effort to learn more about the extent of public transportation and the innovative approaches in these communities, a research program was conducted by the Transportation Systems Center. Transit operations in a number of cities with populations under 150,000 were examined. Thirteen of these cities were subsequently selected to represent a range of socio-economic characteristics, types of transit service, and funding approaches. Case studies were conducted to document the process of establishing transit service policies, operating and cost characteristics, funding mechanisms, usage, and community impacts.

Two companion documents were published together with the case studies. One was a summary of state aid programs and contains a breakdown of the types of transit assistance, technical and financial, currently offered to small cities in each state. It is intended to serve as a resource for communities and to guide states in assessing their own programs. The other was an overview of the case studies and summarizes and analyzes some of the relationships among service, cost, and community response across the cities studied. A condensation of the overview is included in this chapter.

A conference session on small community transit was organized and presented at the 1976 Transportation Research Board (TRB) Conference in Washington. This session included presentations on small city transit planning and operations,

taxi usage in small cities, and a discussion of the cost and service characteristics of the 13 case study cities.

A series of regional Public Transit Seminars for small communities, organized by TSC and UMTA and sponsored by the SMD program, was held in six locations around the country: Chapel Hill, NC; Evansville, IN; Eugene, OR; Merced, CA; Westport, CT; and Boulder, CO. Attendees included local officials from small cities, public and private transit operators, local, regional, and state planners, representatives of citizens' groups, university faculty, consultants, and vehicle manufacturers. The speakers were experienced in various aspects of small community transit operations. Topics included paratransit service options, management, marketing, state support, and federal funding sources and procedures. An optional second day consisted of a tour of the local transit facility, provided by the host community.

Another product of the case studies is a film, Transit Options for Small Communities, produced by TSC to illustrate examples of innovative public transit systems in four small cities. It was shown at the six regional seminars and is being widely distributed to local officials, regional planners, citizens' groups, universities, etc. It provides introductory information on the range of service concepts being applied in small cities and shows how the services are used. The operation and service features of each system are shown, narrated by the local transit officials. In each city, community attitudes toward the service are reflected in interviews with local citizens. Prints of the film are available on loan from UMTA Regional offices and the DOT Public Affairs Office.

The following sections of this chapter contain a condensation of the overview of the case studies, summarizing cost and service characteristics of local transit systems in the 13 cities studied.

One of the Six Public Transit Seminars Sponsored by the SMD Program for Representatives of Small Communities held in Merced, California

THE COST AND SERVICE CHARACTERISTICS OF SMALL COMMUNITY TRANSIT OPERATIONS

Background

This report examines the service, ridership, and cost characteristics of thirteen selected transit systems which are representative of small city transit operations. The case study sites were chosen to illustrate not only a range of service options and results, but also a variety of community settings, service objectives, financing mechanisms, and political environments. Populations range from 9,500 to 170,000; most of the cities are under 60,000. Whereas the larger cities, namely Eugene, Evansville, and Ann Arbor, are admittedly larger than what might be considered small cities, the features of their transit systems were felt to be representative of and appropriate to small city transit operations. Table 8 contains summary characteristics of each of the case study sites.

Service Characteristics

Service Concepts

The case studies describe several variations of fixed-route and demand-responsive service, including combinations of both in integrated systems. Although many small communities have offered what appears to be conventional fixed-route or dial-a-ride service, closer examination reveals special features which have had the effect of customizing the service to the needs of the users.

The fixed-route systems have made use of a number of these special features, examples of which are given here. Hailing of buses has been permitted to reduce the number of designated stops in low population density areas. By providing a central transfer point where all routes converge, passengers can reach any destination with a maximum of one transfer. Also, since all buses converge at the scheduled times and do not depart until all have arrived, the wait time for transferring is minimal, and no walk is required. In East Chicago, IL, Evansville, IN, and Westport, CT, there is a coordinated transfer point at the common end of each city's routes. Eugene, OR, a larger system, has several coordinated transfer "nodes" at which a number of routes have been synchronized. It is clear that transfer coordination is easier to arrange with the

TABLE 8. OPERATING STATISTICS FROM CASE STUDY SITES[1]

	Amherst, Mass.	Chapel Hill, N.C.	East Chicago Ind.	Eugene, Ore.	Evansville, Ind.	Sudbury, Mass.	Westport, Conn.
TYPE OF SERVICE	Fixed-route	Fixed-route	Fixed-route	Fixed-route	Fixed-route	Fixed-route	Fixed-route
SERVICE AREA DEMOGRAPHICS							
Population in Service Area	17,000	32,000	47,000	170,000	139,000	13,500	28,000
Population Density (persons/sq. mi.)	1,000	3,300	4,000	1,700	3,900	550	1,300
COVERAGE AND SERVICE							
(Fixed Route only) Number of Routes	5 regular 3 others	10	3	20	13	7	7 commuter 7 regular
(Fixed Route only) Average Route Length (one-way mi.)	6	N/A	9	13 @ 10 mi. 7 @ 32 mi.	8	5	6
(Fixed Route only) Average Route Time (one-way min.)	25	N/A	45	13 @ 40 min. 7 @ 60 min.	35	15	18
(Fixed Route only) Average Headways (min.)	10 regular 30 others	5 to 40		13 @ 30 min. 7 longer	30 on half 60 on half	120	15 commuter 35 regular
(DRT only) Service Area (sq. mi.)	-	-	-	-	-	-	-
(DRT only) Average Wait Time (min.)	-	-	-	-	-	-	-
Number of Vehicles in Service	16	27	5	47	16	2	8
COST AND PRODUCTIVITY							
Operating Costs per Vehicle-Hour	$7.74	$11.10	$14.50	$16.90	$8.54	$9.85	$11.50
Operating Costs per Passenger (2)	$0.09	$ 0.43	$ 0.57	$ 1.07	$0.37	$1.08	$ 0.74
Passengers per Vehicle Hour (2)	85	26	26	16	23	9.3	16
Driver Wage Rate (5) ($/hr.)	$3.00	$ 3.80	$ 4.00	$ 5.25	$5.00	N/A	$ 4.40
Total Capital Cost (3) (thousands $)	439	1,075	N/A	1,190	N/A	close to 0	255
Lease or Buy Vehicles?	8	B	B	B	B	L	8
Base Fare (4)	0	25¢(6)	0	30¢	35¢	25¢	50¢(6)
Revenue per Passenger (2)	0	$ 0.20	0	$ 0.25	$0.30	$0.20	$ 0.20
Operating subsidy per Passenger (2)	$0.09	$ 0.23	$ 0.57	$ 0.82	$0.07	$0.88	$ 0.54
Operating Ratio (costs/revenues)	undefined	2.1	undefined	4.3	1.3	5.4	3.7
RIDERSHIP							
Average Passengers per Weekday (2)	15,200 (school yr) 5,400 (summer)	13,500 (school yr) 4,000 (summer)	1,050	10,500	3,500	170	1,400
Percentage of Youth Riders	N/A	small	high	25	17	80	55
Percentage of Elderly Riders	small	small	high	10-15	27	small	3
Major Trip Purposes	85% university	86% university	shopping recreational	work school	42% work 21% shopping	school recreational	school work recreational

NOTES TO TABLE:

(1) "N/A" - not available.

(2) "Passengers" refers to completed trips (excluding transfers) when this can be determined.

(3) "Capital Cost" excludes the cost of leading vehicles, equipment, or garage space, but includes planning and evaluation costs.

(4) "Base fare" is the single-ride fare charged to an adult rider, excluding all discounts.

(5) "Driver wage rate" is the standard base hourly pay, including the value of fringe benefits when this can be determined.

(6) These cities rely heavily on transit passes rather than single-ride fares for their revenue from operations.

TABLE 8. (CONTINUED)

		Xenia, Ohio	Bremerton, Wash.	Merrill, Wis.	Ann Arbor, Mich.	El Cajen, Cal.	Merced Cal.
TYPE OF SERVICE		Fixed-route	Subscription Bus	Point Deviation	Pilot DAR	Shared Taxi	Dial-A-Ride
SERVICE AREA DEMOGRAPHICS							
Population in Service Area		27,600	35,000	9,500	16,000	60,500	30,000
Population Density (persons/sq.mi.)		3,100	3,600	1,700	7,300	5,000	3,000
COVERAGE AND SERVICE							
Number of Routes	Fixed Route only	4	24	1	-	-	-
Average Route Length(one-way mi.)	Fixed Route only	6	-	5	-	-	-
Average Route Time (one-way min.)	Fixed Route only	15	20	30	-	-	-
Average Headways (min.)	Fixed Route only	30	45	30	-	-	-
Service Area (sq. mi.)	DRT only	-	-	-	4	12	10
Average Wait Time (min.)	DRT only	-	-	-	11	20	21
Number of Vehicles in Service		7	28	2	3	15	4
COST AND PRODUCTIVITY							
Operating Costs per Vehicle-Hour		$11.70	$ 9.16	$ 9.50	$10.50	$ 8.16	$9.70
Operating Costs per Passenger (2)		$ 1.34	$ 0.17	$ 0.99	$ 1.74	$ 1.28	$0.84
Passengers per Vehicle Hour (2)		8.7	53	9.6	6.3	5.4	11.5
Driver Wage Rate (5) ($/hr.)		$ 3.70	$10/day	$ 4.00	$ 6.00	commission - tips	$3.75
Total Capital Cost (3)		223	N/A	95	35	close to 1	65
Lease or Buy Vehicles?		B	L	B	L	L	B
Base Fare (4)		25¢	35¢	25¢	60¢ (6)	50¢	25¢
Revenue per Passenger(2)		$ 0.15	$ 0.21	$ 0.26	$ 0.47	$ 0.38	$0.25
Operating Subsidy per Passenger		$ 1.19	0	$ 0.73	$ 1.27	$ 0.90	$0.59
Operating Ratio (costs/revenues)		8.9	0.8	3.8	3.7	3.4	3.4
RIDERSHIP							
Average Passengers per Weekday (2)		900	2,240	228	180	600	330
Percentage of Youth Riders		31	0	45	28	N/A	15
Percentage of Elderly Riders		10	0	20	11	67	30
Major Trip Purposes		35% work 33% shopping	100% work	school shopping	34% work 23% school	40% shopping 27% medical dental	35% school 26% work

relatively simple routes and schedules that typify small community transit operations.

Varying forms of demand-responsive, or door-to-door, service have been used in Merced, CA, Merrill, WI, El Cajon, CA, and Ann Arbor, MI. The names attached to demand-responsive services, such as dial-a-ride, dial-a-bus, or shared taxi, refer to the mechanism for providing the service. From the point of view of the user, they are identical in the sense that the user calls to request service, waits to be picked up, and is transported to his destination, whereas other passengers may be picked up or dropped off enroute. Demand-responsive service is usually more direct than fixed-route transit, although the travel time may not be any less.

An interesting hybrid version of demand-responsive and fixed-route service was adopted in Merrill, WI. In this concept, referred to as point deviation, the vehicles must stop at fixed checkpoints and are not required to follow a specific path between two checkpoints. Users can hail the buses, board at checkpoints, or call in for a pickup. Passengers who board at a checkpoint may request doorstep delivery or travel to another checkpoint. A premium fare is charged for the doorstep service. The basic advantage of this concept is that it provides greater coverage than fixed-route service and increased capacity over purely demand-responsive services.

Considerations Regarding Choice of Service Mode

Many characteristics of the community are considered in developing a transit system, including the size and shape of the community, the potential users, population density (or in some cases, the estimated demand density), the area to be served, and the location and size of major activity centers such as the downtown, shopping centers, schools, and large employers. If the system is not aimed at a population which is "mobility-limited," e.g., elderly or handicapped, and if much of the travel appears to be related to a few main activity centers such as a downtown area, a railroad station, or a high school, then fixed-route systems can perform very efficiently. The clearest illustration of this pattern has been the performance of the two fixed-route systems which have provided service to university campuses. Amherst, MA, and Chapel Hill, NC, have provided comparatively frequent service, at least in peak hours, and have achieved high productivities--85 and 26 passengers per vehicle hour, respectively.

Among systems serving a more general population, Evansville, IN, and East Chicago, IL, have also been able to operate with high productivities, around 25 passengers per vehicle hour. In Evansville, a defined and concentrated downtown area appears to have been the crucial ingredient, while in East Chicago, the extremely high residential density has apparently accounted for the high vehicle productivity. (About 85 percent of East Chicago's land area is devoted to industrial uses, so that the residential density on the remaining land is about 16,500 persons per square mile.) Even without these special circumstances, the fixed-route systems in Westport and Eugene have operated with moderately high vehicle productivities, averaging about 15 persons per vehicle hour.

There are, nonetheless, several arguments for using a demand-responsive service in many small community situations. One argument is based simply on cost; vehicle utilization would be improved in low-density environments and cost per passenger lowered, if vehicles were not required to travel at times when or in places where few people want to go. Two other arguments are based on the service advantages of a demand-responsive system; such a system can offer riders more flexibility in choosing their destinations and departure times, and usually provide door-to-door service in a single vehicle, eliminating both walk time and transfer time.

In addition, a community in which service to the elderly is a major goal may have no alternative but to provide demand-responsive service, even when it involves an additional cost. For elderly people, the task of walking to a bus stop and waiting for the bus to arrive can be onerous or even impossible. Although El Cajon, for instance, has a high population density for shared-taxi service (about 5,000 per square mile), the existing fixed-route service was attracting few elderly riders. However, two-thirds of the riders of the new shared-taxi service have been elderly. Two of the three systems which attracted 30 percent or more of their riders from among the elderly offer door-to-door service. In Westport, the lack of door-to-door service is thought to be the cause of the unexpectedly low usage of the system by elderly riders, who comprise less than 3 percent of the total ridership.

It seems fair to conclude that demand-responsive service will generally be superior to fixed-route service with respect to comfort, convenience, and flexibility. However, it is important to observe that demand-responsive operations do not necessarily provide better service than

fixed-route systems. Demand-responsive service shows no evident advantage with respect to overall travel time, and it can be inferior to fixed-route service with respect to reliability. The traveler cannot be confident about either his wait time or his travel time, since both depend on the volume of total demands on the system at the time he seeks to travel.

Service Policy and Quality of Service

Demand-responsive systems can be structured to serve a few destinations only (many-to-few) or provide service anywhere in the area (many-to-many). In an attempt to balance the demand over the day and serve the largest number of users, several special features have been employed in the cities studied. Merced has provided prearranged subscription service (many-to-few) for school and work trips during the busiest (peak) period and many-to-many service in the off-peak. The Merrill system transports small children to and from day care centers in addition to providing public school transportation for students ineligible for the local school bus service. Charter trips to shopping destinations for senior citizens and telegram and package delivery have also been included in the Merrill service.

Westport has been operated as a pure fixed-route service, but the drivers have occasionally deviated from their route to take a passenger to his door, particularly in inclement weather or if the person was elderly. In most small cities the bus drivers assist elderly or infirm passengers who have difficulty boarding the bus. Such examples of courteous, personalized service seem to be an important unique feature of transit in small communities.

Hours. In small as in large transit systems, there is a wide variation in days and hours of service. In the cities studied, hours have ranged from a low of eight hours per day in East Chicago to 24-hour service in El Cajon. A majority of services have operated Monday through Saturday. On weekends the level of service in these systems has usually been cut back. Hours of service have usually been decreased; headways on fixed-route systems have been increased; and the number of vehicles available on demand-responsive systems has been reduced. Xenia has provided fixed-route service on weekdays and demand-responsive service on Sundays and holidays.

Headways. Fixed-route systems typically adjust their service to the demands of riders by providing more frequent service at times of the day when ridership is greatest, thereby increasing both capacity and service quality. The "peak" in small community systems often occurs at different times of day than the traditional commuter peak, and often extends over more hours, therefore, it is important to note that the following discussion of peak and off-peak headways refers to the system peak rather than the conventional morning or evening peak.

Headways have generally been about 30 minutes, but were lower for the two campus-community systems. Some minor routes in the larger systems have had headways of up to one hour, and the defunct Sudbury, MA, system operated on two-hour headways. This minimal level of service was a primary cause of the lack of use by the community which forced the town to terminate operations.

Demand-responsive services must also adjust their vehicle deployment to the level of demand if they are to maintain a consistent level of service with respect to wait-time at all hours of the day. In El Cajon, the number of taxis in service varies from 2 to 16 over a 24-hour period, depending on demand and time of day. Merced has been operating at capacity due to the fleet size (4 vans), and wait times have deteriorated during peak periods. They have provided a subscription service in the morning and evening to increase system capacity during these periods. Ann Arbor's pilot dial-a-ride project provided many-to-few service between the service area and selected points downtown, and on an as-available basis, many-to-many service within the service area. In peak periods the many-to-many service was generally not available.

Fare Policies

On the fixed-route systems studied, fares have varied from zero to 35 cents for systems which have relied primarily on single ride fares for revenue, rather than passes. Whereas Merced's dial-a-ride fare was 25 cents, Ann Arbor's was 60 cents, and El Cajon's shared-taxi service was 50 cents. In Merrill, the fare depends on the type of service. Checkpoint-to-checkpoint service costs 25 cents, the checkpoint to doorstep fare is 40 cents, and doorstep-to-doorstep service costs 50 cents. In most cities, discounts are offered to youths and senior citizens.

Prepaid passes, sold on a weekly, monthly, or annual basis, permit unlimited rides for a fixed cost. This results in substantial discounts for regular users, e.g., in Westport, where the basic fare was 50 cents, over 20 percent of the population have purchased annual passes and the average fare per ride for regular users was less than 20 cents. Tickets and passes have often been purchased in bulk by institutions in the community. Some communities have controlled pass misuse by including a photograph of the user on the pass.

Free fare service was provided by the campus-community fixed-route operation in Amherst and by the East Chicago system, which was designed to serve low income transit dependent citizens. In East Chicago the free fare policy caused much joy-riding by teenage users, but this problem was overcome by providing passes for teenagers which limited them to two rides per day.

Ridership and Cost Characteristics

Ridership Response

Table 8 contains a summary of ridership, as well as the cost characteristics of the small community systems. The highest ridership was found on the university-community fixed-route services, the lowest on the demand-responsive and route-deviation services. In Eugene, which offered a comprehensive city-wide, fixed-route transit service throughout a fairly large-sized community, ridership was also high (an average of 10,500 passengers per weekday). Ridership on the other fixed-route services and the subscription bus service was considerably lower than that of Eugene but higher than those of the demand responsive systems. Ridership on Sudbury's fixed-route system was an exception, being lower than any of the demand responsive services.

In all of the services for which there was a case study except Sudbury, ridership grew significantly following the introduction of service (see Table 9). In most cases ridership at least doubled during the first year of operation. El Cajon's ridership might not have stabilized as soon as it did had the City of El Cajon vigorously marketed its transit service. However, with the manner in which the taxi operator has billed the city for the shared taxi service, the subsidy per passenger that the City has been paying the operator would not decrease as the number of passengers carried increased. Because of the city's limited

TABLE 9. CASE STUDY COMMUNITIES-RIDERSHIP GROWTH

DECLINE	STABILIZED	STILL RISING	AT CAPACITY
SUDBURY (1/2 YR)	EL CAJON (X2 IN 1 YR)	MERRILL (X2 IN 3/4 YR)	CHAPEL HILL (X1/3 IN 1 YR)
	XENIA (X2IN 1 YR)	EVANSVILLE (X4 IN 4-1/2 YRS)	WESTPORT (X2 IN 1 YR)
	EUGENE (X5 IN 5 YRS)	ANN ARBOR (X3 IN 1 YR)	MERCED (X2 IN 1 YR)
		AMHERST (X6 IN 3 YR)	

budget and inability to achieve any economies of scale, El Cajon has not sought further ridership increases. It seems apparent from the case studies that considerable ridership growth is likely during at least the first year of service providing supply is sufficient to meet demand. In at least three cases, Eugene, Evansville, and Amherst, ridership continued to grow for several years.

The principal users of transit in the case study communities were the transit dependent. Among transit dependents, the elderly are an important segment requiring service. However, in only three of the communities have elderly riders exceeded 30 percent of the total ridership One of these was El Cajon where over two-thirds of the riders were elderly. In six cases the elderly have accounted for less than 10 percent. This is in large part because only three of the small communities have offered door-to-door service. Of the three communities that have attracted over 30 percent elderly riders, two have provided door-to-door demand-responsive service.

A particular transit dependent user group which stood out in several communities has been the youth market, consisting chiefly of young teenagers in the age range of 11 to 15. Westport has been the clearest illustration of the potential attractiveness of public transit for this group. Transit has freed youth from dependence on their parents for transportation and has relieved their parents of chauffeuring duties. As was mentioned earlier, in Eash Chicago transit passes had to be required on a free-fare system to limit teenage riders to two rides per day.

Another large group of users of transit in the small communities have been those for whom auto travel has been possible, but inconvenient, such as members of one-car families or college students wishing to avoid campus parking problems.

There does not appear to have been one dominant trip purpose for users of the different small community services. In the two college-community services and in the Merrill and Westport services, school has been the major trip purpose. In general, considerably less emphasis has been placed on serving the work trip in small community transit than in large urban area transit. Bremerton, WA, has the only transit operation primarily directed at serving the work trip. However, in four of the other small cities, at least one-third of the trips have been work trips. East Chicago, because of limited funds, purposely avoided serving many work trips by simply not offering service until 10:00 a.m.

Other major trip purposes of small community transit users have included recreation, shopping, and medical trips.

Factors Influencing Operating Costs

In designing their transit systems, the small communities had to consider the cost implications in making the final decisions on which service options and policies to select. In some cases cost constraints ruled out the more costly options. Of the two cost categories -- operating and capital costs -- operating costs were the major concern because the small communities had to cover a large percentage of these costs. Capital costs, while not minor, were almost entirely subsidized by Federal and state grants.[1]

A basic measure of operating cost is the average cost per ride. In our sample this ranged from nine cents in Amherst to $1.74 in the Ann Arbor pilot dial-a-ride project. The cost per passenger clearly depends on both the efficiency with which the transit vehicles are operated (measured by the cost per vehicle hour of service) and the vehicle productivity (the number of passengers carried per vehicle hour). The cost per passenger trip is exactly the quotient of the cost per vehicle hour and the vehicle productivity.

Factors which affect operating costs do so by affecting either operating efficiency or vehicle productivity. Reducing idle labor time produces a cost savings by reducing the cost of each vehicle hour of service; streamlining of routes reduces the cost of carrying each passenger by carrying more passengers in the same number of vehicle hours. In some cases, particular operational changes will affect both operating efficiency and vehicle productivity.

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[1]It should be noted that the cost data in Table 8 are not in all cases limited to operating costs. The systems which leased their vehicles or service have contributed to the capital cost of the vehicles through their lease payments. In cases such as El Cajon where the service was purchased from a private operator, the fee has included not only a charge for depreciation of the vehicles, but also a contribution to the taxes paid by the leasing company. Both of these items are excluded from the cost data for publicly owned and operated systems.

Choice of Service Mode. The choice of mode is an important determinant of operating costs. A direct comparison of per-passenger costs between the fixed-route and the demand-responsive systems in our sample indicates that demand-responsive systems have generally been more expensive. The operating costs per passenger in the four demand-responsive systems (including the point deviation system in Merrill) were in the $0.75 to $1.75 range, while the fixed-route services typically were per-passenger costs in the range of $0.35 to $1.25, and ran as low as nine cents in the high-density Amherst campus service and seventeen cents in the highly specialized Bremerton subscription bus service. These variations in cost are a direct reflection of the differences in vehicle productivity, which have averaged over 50 riders per hour in the Amherst and Bremerton systems, dropping to between 9 and 25 passengers per hour in the other fixed-route systems, and falling to the neighborhood of 6 to 11 passengers per hour in the demand-responsive systems.

The data available do not contain any examples of demand-responsive service in truly low-density settings. However, Merced, at 3,000 persons per square mile, is the closest case. Merrill, with a density of 1,700, has operated a system that cannot be classified as fully demand-responsive. Apparently, then, a determination of whether demand-responsive service is cheaper per passenger than fixed-route service in a low density environment cannot be made with the data from the thirteen case study transit systems. Nonetheless, the data do contain examples of fixed-route service which appears to have worked in low density areas.

Westport, with a population density below 1,500, has provided fixed-route service at least as cheaply on a per-passenger basis as Merced's dial-a-ride. Evansville, with a population density only slightly higher than Merced, has provided fixed-route service at a third of Merced's cost per passenger. The vehicle productivities of the fixed-route systems have been significantly higher than those in Merced, which is high compared to most U.S. demand-responsive systems.

It appears that at least two situations can be isolated in which fixed-route systems can operate viably in low density areas. The first is a setting in which activity centers are geographically concentrated, even though residences are dispersed. Amherst is an example of this, as is Evansville and, to some extent, Westport. This situation can be created by a defined downtown area, by a high school

or a university, a railroad station, or even a recreation area such as a park or a beach. Demand-responsive service is likely to achieve its greatest efficiency, relative to fixed-route service, in places where such large activity centers do not exist, or at times when they are not in operation.

A second situation is one in which the trips being served need not be rigidly confined to particular times of departure or arrival. This will often be the case with shopping trips, with trips to visit friends, or other recreational trips, which are often made by both youthful and elderly riders. For these trips travelers may not find it difficult to adapt their departure times, and even their destination choices, to the available service. In this case a fixed-route service may cause demand patterns to be more concentrated, and vehicle productivities to be higher, than they would be if a more flexible service were provided in the same setting. If costs per vehicle hour are comparable, and if passengers in fact behave in this way, then fixed-route service will be cheaper even in a low-density environment. Of course, the quality of service will also be lower, since passengers are not as free to choose their own travel times as they would be with demand-responsive service.

One final point is relevant to the cost comparison between fixed-route and demand-responsive services. For many communities, the critical comparison will not be in the relative costs per passenger but in the relative subsidies per passenger. Often, since demand-responsive service is viewed as a premium service, relatively high fares have often been charged. Ann Arbor charged 60 cents per ride for its dial-a-ride service, while El Cajon charged 50 cents for taxi tickets. These fares were higher than any of the fares on fixed-route systems in our sample except Westport, the vast majority of whose riders have used prepaid passes. However, the higher fares were needed to offset the higher costs; the operating subsidy per passenger on the publicly-funded, demand-responsive systems was generally higher than for the fixed-route systems.

<u>Degree of Peaking</u>. Since service is less oriented toward work trips than in most larger systems, transit ridership in small communities tends to exhibit much less peaking by time of day. The peaking which does occur is often more frequent or more extended than the usual rush-hours, reflecting school dismissal times in addition to the normal work schedules.

This extended peaking is favorable from an operating cost standpoint (in terms of cost per passenger), since it means that less extra vehicle capacity to handle peak hour demands is needed, and vehicles are less likely to be idle in off-peak hours. Also, relatively flat or extended peaks lessen the need for part-time labor and reduce the amount of unproductive labor time which must be paid for if full-time labor must be employed on continuous shifts.

Entrepreneurship. Another factor which significantly influences operating cost may best be described as "entrepreneurial performance," and is well illustrated by Evansville's achievement of operating a fleet of sixteen 19-passenger vehicles at a cost of $8.54 per vehicle-hour, despite paying its drivers a comparatively high wage of $5.00 per hour, and covering 81 percent of its operating costs from the farebox. Among demand-responsive systems, Merced and El Cajon have similarly been successful in controlling costs through flexible and close relationships with the labor pool and imaginative cost-saving procedures. Some systems have taken such steps as inducing local businessmen to print schedules and contribute advertising spots, leasing unused garage space for a maintenance facility, and sharing back-up vehicles with other government agencies.

One notable aspect of this ingenuity has been the effort of several system operators to have their accounting done in such a way that other budgets absorbed a part of the overhead. By functioning as a department of the city, Evansville's transit service has avoided bearing such expense burdens as the administration of its payroll, which was handled as part of the general city payroll. In a similar way, much of the overhead from the Amherst campus service was absorbed in the general university budget and was not recognized as an operating expense of the system.

Transit Viewed as a Public Service

An underlying issue in examining the effects of various factors on operating costs is the extent to which farebox revenues will cover operating costs. The experience in the sites considered here confirms a belief that is achieving wide acceptance: public transit in small communities cannot be expected to pay for itself out of the farebox. Among the communities considered here, only Bremerton, which employed part-time drivers and provided very limited, specific service, has succeeded in covering all of its operating costs from fare collections. All others except Evansville

have covered less than half of their operating expenses from fares. In several communities, previously existing private transit services had ceased operations because of an inability to cover costs.

The total operating subsidy per passenger-trip varied in our sample from a low of seven cents in Evansville's service and nine cents in Amherst's service, up to well above a dollar for Ann Arbor's dial-a-ride and Xenia's fixed-route service. These levels of subsidy should not be regarded as the minimum levels that the transit systems could achieve in each community. The transit systems did not necessarily select their fare and service levels so as to minimize their operating losses, although most worked within the constraint of a maximum total subsidy from the financing body. The choice of fare levels and fare structures, e.g., whether and to what extent to offer discounts to special groups of riders such as the elderly, is a fundamental policy decision; it can be based on criteria other than loss-minimization, such as ridership maximization, the level of service maximization, or some combination of criteria.

Because public transportation is increasingly being viewed as a public service, some comparisons were made with other community services, e.g., street maintenance and refuse collection. Table 10 shows the per capita annual subsidy for transit compared with the annual per capita cost of street maintenance (road repairs and street cleaning) and refuse (garbage and trash) collection. For the communities studied, the average per capita cost of public transportation was about $7.00, compared with an average of $10.00 and $11.00 for street maintenance and refuse service, respectively.

These transit systems are to varying extents meeting the need for public transportation in their community. In general, they have enjoyed community support with established sources of funding; transit is viewed as a public service, requiring financial support to meet expenses. Operating deficits are currently ranging between $0.07 and $1.20 per ride. In some of the localities where temporary funding has terminated, the citizens agreed to assume the costs of continuing operations. In other communities where state and/or federal funding is temporary, the taxpayers will likewise be asked to weigh the community benefits of public transit against an increased financial responsibility.

TABLE 10. SMALL COMMUNITY TRANSIT—COMPARISON OF PER CAPITA ANNUAL COST OF TRANSIT SUBSIDIES AND PUBLIC SERVICES

CITY	PUBLIC TRANSP.	STREET MAINTENANCE	REFUSE SERVICE
AMHERST, MASS	6.70	–	1.90
CHAPEL HILL, N.C.	14.90	11.40	14.50
EAST CHICAGO, IND.	3.80	11.00	24.60
EL CAJON, CALIF.	2.70	6.50	PRIVATE
EUGENE, OREGON	13.90	4.20	PRIVATE
EVANSVILLE, IND.	0.50	10.20	7.20
MERCED, CALIF.	1.90	7.10	20.50
MERRILL, WISC.	5.30	22.70	6.70
SUDBURY, MASS.	3.30	5.00	1.07
WESTPORT, CONN.	8.00	–	PRIVATE
XENIA, OHIO	11.60	–	–
AVERAGE	6.60	9.80	10.90

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CHAPTER 7

ANALYTICAL STUDIES

In addition to the activities described elsewhere in this report, a number of analytical studies have been undertaken which are characterized by the dual objectives of supporting various elements of the SMD Program and contributing to the advancement of the state-of-the-art in transit planning and operations. These studies play a pivotal role in the SMD Program activities of concept definition and evaluation and demonstration planning and design. Typically, these studies also result in the generation of new insights and analytical techniques which are useful to transit planners and decision-makers across the nation.

The SMD analytical studies do not, to the extent that it is known, duplicate work that has been done elsewhere. Rather, they often address major gaps in our knowledge or serve to synthesize, generalize, and extend results previously available from diverse sources. Frequently these studies are of interest to other elements of UMTA and DOT, and they are sometimes sponsored jointly. Because the focus of this research is on innovative concepts, these studies enhance the overall effectiveness of the SMD Program. Analytical studies underway in conjunction with the program include:

- Research on the impact of pricing and service variations.
- Simulation and analysis of bus priority strategies to assess the potential of a variety of traffic management policies.
- A transit reliability study to determine how transit reliability affects travelers and operators and influences the decisions they make and to develop and implement strategies for improving transit reliability.
- A research project to determine the travel requirements of various classifications of handicapped people and to determine cost-effective service alternatives.

- The development of a demand-responsive transit patronage model that can be used to estimate demand and service requirements for this type of service.

- Auto Restricted Zone Feasibility Study

- Multi-User Vehicle System Feasibility Study

- Shared-ride Auto Feasibility Study

These activities are described in the following paragraphs.

PRICING AND SERVICE INNOVATIONS

Analytical studies related to pricing and service innovations can be divided into three broad areas: research and development of auto user pricing policies; transit fare policy analyses; and transit service variation analyses. These studies are designed to identify the effects of different transportation system level of service parameters on transit ridership and mode choice.

Auto User Pricing

Work in the auto user pricing area has consisted of a major study of road pricing, mode choice modeling, and parking studies. Over the past few years there has been an increasing interest in an innovative approach for improving urban transportation in congested areas -- simultaneously discouraging the use of low-occupancy vehicles and encouraging the use of high-occupancy vehicles. The approach taken by SMD combines parking and road pricing, in which vehicles are charged for using congested streets, with expanded service by buses, shared taxis and other transportation modes which occupy relatively little space per passenger carried. Congestion charges are essential to the service expansion because improved traffic conditions permit the higher-occupancy vehicles to operate more efficiently. The general objective of the approach is to create conditions which will significantly alter travel behavior in favor of high-occupancy modes. Not only does this promise more mobility, better use of central areas, and reductions in pollution and energy consumption, but it will also generate a new source of revenue to support transit improvements or otherwise improve the local fiscal picture.

Road Pricing

Road pricing refers to the placement of some sort of tariff on users of heavily congested roadways. The road pricing study provides detailed analysis of how a road pricing scheme could be designed, implemented, administered, and enforced. The research is intended for use by planners and analysts to assist the technical staff in providing city officials and their constituents with a description of the scheme: what the available alternative plans and procedures are; how area motorists will be affected; what the city officials have to do to plan, administer, and enforce such a scheme; and what institutional changes would be required for successful implementation. The analysis suggests that considerable flexibility in design of the plan will be available to the city planners so as to enable them to develop a scheme most appropriate for their particular area.

A report has been prepared which discusses the following topics: determination of the scope of the road usage charge scheme; selection of the method for implementing a road usage charge scheme; design of supplementary licenses; distribution of supplementary licenses; enforcement; publicity and information; collateral traffic measures; and institutional, political and administrative considerations.

Mode Choice Modeling

An analysis was performed to estimate the mode choice behavior changes which would result from the application of various road pricing designs in Madison, WI, Honolulu, HI, and Berkeley, CA. This estimation used a behavioral disaggregate demand model that included travel cost as an attribute which could influence behavior. Choices among three modes were considered; autos with a single occupant, carpools, and transit. Traveler responses were estimated separately for commuting and non-commuting trips since the importance of costs differs between these two trip purposes. The impact of road pricing on travelers will vary depending upon their incomes. In this preliminary analysis, the distribution of affects by income groups was not determined. The distribution of effects between residents and non-residents of the pricing jurisdiction was estimated.

For commuting trips the effects of road pricing on mode choice and route choice were examined. Some commuters who travel through an area before pricing is applied within it

will switch routes rather than pay the price. This response is desirable when congestion is prevalent within the area.

For non-commuting trips, the effects on mode choice and destination choice were analyzed. Destination choices were considered between the priced area and all other areas. The exact location to which shopping trips divert was not determined. With peak period pricing, non-commuters would be affected much less than with all day pricing. Many travelers could reschedule shopping, personal business, and recreation to the offpeak hours.

From the demand estimation, other characteristics of road pricing were determined. The revenues raised from pricing were estimated from the number of vehicles paying the charge. The financial viability of the new transit service was determined from the fare levels and patronage estimates along with cost estimates from the service. The reduction in road traffic commensurate with improvements in pollution levels and safety could lead to the priced area becoming more attractive to shoppers. This effect can only be determined from the actual implementation of road pricing. The reduction in road traffic will lead to reductions in the emission of pollutants. However, this was not estimated in the preliminary analysis because the ambient concentrations of pollutants in a specific area are not highly correlated with the emission levels, except for carbon monoxide.

Parking Pricing

An analysis has been performed to assess various parking pricing alternatives that would lead to a reduction of traffic related problems and change travel behavior in favor of high occupancy modes in urban areas. These alternatives have been assessed as to their potential for SMD demonstrations.

Increased parking charges will be less effective than road pricing for several reasons: trips that formerly bypassed the area may re-route through it once congestion is reduced by parking controls; a significant proportion of parking is provided by employers; and automobile usage is very insensitive to parking cost increases.

Four strategies have been chosen for imposing charges on urban parking. They are arranged in increasing order of complexity of implementation and in decreasing order of effectiveness.

Strategy 1: Revenue Tax. A flat tax rate of 25 to 100 percent would be levied against all revenue from municipal, commercial and private parking operations. Long-term municipal on-street parking rates would also be increased. Responsibility for administering the tax program would fall to the city agency responsible for sales and/or property taxes.

Strategy 2: Parking Space Tax. Operators would be charged an annual fee for every space they provide regardless of who uses it, when it is used, or for how long. The spaces in each municipal, commercial, and private facility would be inventoried, and all owners would be assessed yearly for each space. The city would be divided into zones according to the severity of congestion in different areas. Rates would be the highest in areas experiencing the most congestion, with perhaps two or three other zone-types and tax rates.

Strategy 3: Morning Peak Surcharge. Providers of municipal, commercial, and private parking would be required to make a record of the number of cars parked in their facilities between the hours of, say 7:30 a.m. to 10:00 a.m. on weekdays, and would be assessed an annual fee for these automobiles. As in strategy 2, zones and different surcharges would be designated according to the distribution of congestion throughout the city, and the city tax collection agency would be responsible for administration.

Strategy 4: Parking License. During the two or three peak morning hours on weekdays, all cars parked anywhere within zones designated by the city would be required to display permits which would be sold for a fee. Daily, weekly, and monthly stickers would be available at a number of convenient locations such as municipal parking lots, service stations, banks, and post offices. A special force of authorized police personnel, such as "meter maids" would be used to enforce the license requirements.

Transit Fare Policies

Transit fare is an important determinant in mode choice decisions as well as a major source of revenue to the transit operator. A subset of transit fare policy options includes fare-free CBD's, areawide free fare, prepaid passes, and multi-modal pricing. Work in this area has included both case studies and model development.

San Diego Transit in San Diego, CA, has employed a number of innovative techniques to successfully increase ridership. A study of their transit system indicated that large increases in ridership are definitely related to the expansion of service and an initial decrease in fares but are not totally explained by these factors. Among the reasons why San Diego's system is so successful may be the management and operating techniques that are not typical of most transit operations: fitting its service to people's needs through origin-destination studies and user surveys; informing the public about the service and how to use it by employing information packets, advertising, phone book transit maps, schedules on bus stop sign posts, and instruction programs; knowing constantly what is happening with the service and how it is being used; and being able to experiment with service with a high degree of flexibility.

Model Development

Experience in San Diego from January 1972 through April 1975 is being used to formulate and calibrate a model which can be used to identify ridership changes due to cost and service modifications. Data taken from monthly ridership, service, and financial reports and disaggregated by route provide a rich information base.

The model being developed is policy oriented. By focusing the analysis on basic variables such as fare, speed, frequency, comfort or reliability, all of which are of major importance to the decision process of potential riders, the model will be capable of providing guidance as to the relative efficiency of policies aimed at changing some service characteristics of the transit industry. At the same time it is designed to account for simultaneity among service variables. Demand is hypothesized to depend on a set of endogenous service variables which include frequency, speed, and comfort, and on a set of exogenous service variables plus socio-economic and other factors. Supply depends on demand, availability of buses and drivers, and cost and revenue factors. Speed depends on the age of the bus, number of bus stops, and average passengers per seat.

Preliminary analysis indicated that no cause and effect relationships can be determined using system level data since system measures differ importantly from route to route, and aggregation of route information would not reveal these differences. The analysis currently underway employs data on a route-specific level.

A fully competitive mode choice model is being tested as a forecasting tool to predict the impacts of offpeak fare elimination on current transit riders using data from Trenton, New Jersey. If the model is found to be effective in forecasting impacts of these types of system change, then a tool is available for testing and simulating impacts of alternative system fare and service changes before costly and time-consuming field experimentation is initiated. The model is sensitive to changes in travel times and out-of-pocket travel costs, is modally interactive (having both definable elasticities within modes and cross elasticities among modes), and can treat travel decisions of people traveling together as a group.

The work plan for applying the model to the Offpeak Fare Elimination Demonstration Project in Trenton contains the following elements: a preliminary prediction of impact of offpeak fare reduction on existing travelers; the establishment of data requirements and coordination of data preparation; the application of the model to predict outcome of demonstration project; a final report including detailed comparisons of observed versus predicted transit line volumes.

Case Studies and Concept Development

A case study evaluation of fare programs has been performed that reviews the theory and practice regarding price and service improvements including the preparation of a comprehensive bibliography on this subject. The evaluation reflects the experience of some 76 different cities which have operated reduced or free-fare transit services of one form or another. This compilation has been made on the basis of published material, telephone inquiries, and documantary information provided by the transit operating agency. This evaluation has been useful in numerous ways:

- estimating local community interest for innovative fare and service programs,
- defining the role of innovative programs in the transit industry and business community,
- assisting UMTA in the development of demonstration concepts, and

- determining how effectively these demonstration concepts meet the travel needs of the transit user.

Table 11 lists some of the cities which have instituted fare reductions in the last five years or have operated fare-free services. The table focuses on fare-related pricing issues which have already been initiated on a local basis. These issues can be identified in terms of five major categories which include policies which predominately affect price, area, time, user, and special promotional purposes.

a. Price oriented programs are predominately directed at the fare charged. They are either fare-free or reduced-fare. Fare-free programs are usually implemented over the whole system irrespective of time and user. However, there are cases of fare abolition on a zonal basis (usually CBD) or route (specific corridors).

b. Area oriented programs are geared to a geographic region. Two major distinctions made in the case studies are area-restricted and area-wide. In area-restricted programs, selected zones are usually identified for implementation such as the CBD. Area-wide programs represent the ultimate limit of geographical area served by the transit system.

c. Time oriented programs are directed at depicting policies over a day or over a week. Time-restricted experiments include offpeak reductions of fare where there is usually unused capacity.

d. Special user oriented programs are directed at elderly and handicapped and, in some cases, children and university personnel. In some cases, university transit systems serve more than the academic community.

e. Promotional programs are implemented on a temporary basis and are used for attracting riders to the transit system or stimulating CBD activity. They may be oriented either at the price, area, time, or user aspect of the fare policies.

In many of the case studies, the fare reduction was not instituted as an isolated element, but rather was part of an overall effort to improve transit. Occasionally, it was to

TABLE 11. FARE-RELATED PROGRAMS IN SELECTED CITIES

Fare-Free: All Day		
Commerce (Cal.)	East Chicago (Ind.)	Wilkes-Barre (Pa.)
Fare-Reductions: All Day		
Akron (Oh.)	Louisville (Ky.)	San Diego (Cal.)
Atlanta (Ga.)	Los Angeles (Cal.)	Seattle (Wash.)
Auburn (N.Y.)	Manchester (N.H.)	Toledo (Oh.)
Cincinatti (Oh.)	Rochester (N.Y.)	Topeka (Kan.)
Houston (Tex.)	Sacramento (Cal.)	Tulsa (Okla.)
Independence (Mo.)	St. Louis (Mo.)	Winston-Salem (N.C.)
	Salt Lake City (Ut.)	
Reduced Fares in Specific Areas: All Day		
Birmingham (Ala.)	Duluth (Minn.)	Pittsburgh (Pa.)
Charleston (W. Va.)	Fort Worth (Tex.)	Portland (Ore.)
Chicago (Ill.)	Houston (Tex.)	Rochester (N.Y.)
Dallas (Tex.)	Manchester (N.H.)	St. Paul (Minn.)
Dayton (Oh.)	Minneapolis (Minn.)	Seattle (Wash.)
	Norfolk (Va.)	
Reduced Fares with Time Restriction		
Allentown (Pa.)	Madison (Wisc.)	New York (N.Y.)
Gainesville (Fla.)	New Castle (Pa.)	Pittsburgh (Pa.)
Reduced Fares in Specific Areas: Time Restrictions		
Akron (Oh.)	Cincinatti (Oh.)	San Antonio (Tex.)
Albany (N.Y.)	Columbus (Oh.)	Syracuse (N.Y.)
Boston (Mass.)	New York (N.Y.)	Westchester County (N.Y.)

TABLE 11. (CONTINUED)

Promotional Fare Reductions		
Allentown (Pa.)	Kansas City (Mo.)	New York (N.Y.)
Boston (Mass.)	Madison (Wisc.)	Omaha (Neb.)
Denver (Colo.)	Nashville (Tenn.)	
Special User Fare		
Amherst (Mass.)-- University		
Toledo (Oh.)-- Elderly and Handicapped		
New York (N.Y.)-- Senior Citizens		
Madison (Wisc.)-- Senior Citizens		

facilitate settlement of some sort of jurisdictional dispute over transit fares and transit service. In still other cases, it was part of a financial arrangement for funding transit deficits out of new sources. In the majority of cases, the fare reductions were made in conjunction with service improvements. According to the transit agencies contacted, benefits of the fare reduction programs include:

- Increased transit ridership
- Reduced congestion
- Reduced energy consumption
- Stimulated trade in the CBD area
- Improved attitudes toward transit
- Economic relief to members of the population
- Improved travel mobility

A study of reduced fare and fare-free experiences in CBD's is currently underway. Case studies will be performed on four cities having a fare-free policy in their CBD's. Cities that have expanded their service as well as those offering no service improvements will be examined. In addition, several case studies will be performed on other fare experiments such as fare-free systemwide, fare reduction, and offpeak only fare-free. Each case study will contain the following elements: a discussion of the area and transit service; a description of the pricing (and service) innovations; an analysis of changes in tripmaking and modal shift by socio-economic group; an analysis of changes in costs and revenues to the transit operator; an analysis of the economic impact on the business community; and an analysis of impacts on traffic congestion. The four CBD fare-free studies will be synthesized into a planning manual to provide implementation guidelines for cities planning such experiments.

A study has been designed to summarize the impacts of transit fare increases in cities over 50,000 population in order to provide guidance to transit companies considering fare increases. Up to twenty-five transit operators will be queried in depth. A case study in the suburban Washington, D.C. area of Northern Virginia has already been performed. This study reports elasticities of transit demand which were observed during a price increase in September 1975. The study also describes the impact of the fare increase on auto usage in general and carpoolers in particular. The fare increase applied to peak period travel only; offpeak fares were unchanged. Thus it was possible to observe shifts in travel from peak to offpeak travel periods. In addition, a comparison of fare elasticities has been made between

premium express bus service and typical urban arterial bus service.

An exploratory study of multimodal pricing strategies is being conducted to develop a strategy designed to promote and enhance relationships among system users and the system's financial supporters. The price-related parameters include tolls, parking fees, area or zone entry charges as a function of vehicle occupancy, tolls related to time of usage, fares collected at time of system usage (fare box charges), prepaid fares, and fares billed subsequent to usage. Modes being considered include auto, fixed rail, buses, and paratransit. Topics being explored include fare differentials among modes, out-of-pocket charges versus total charges, "package fare" options that include one price for multimodal trips and special transit discounts within the central area for persons who commute by "efficient" modes, fare differentials among modes compared to the level of service provided, cost differentials among the various transit modes operating in a similar environment, and identification of users of various modes and identification of revenue sources.

This research began with a short but concentrated review of the literature to determine the state-of-the-art and to assist in identifying additional avenues of exploration. A paper will be produced suggesting potential opportunities to explore cross modal pricing-usage relationships in the real world. Concepts and brief descriptions will be developed for experiments and demonstrations which will lead to a more comprehensive understanding of multimodal pricing relationships.

Transit Fare Prepayment

Transit fare prepayment schemes offer another means of increasing transit vehicle productivity. A study of fare policy and fare collection mechanisms has been conducted to assess the potential of pre-paid passes. One of the basic hypotheses being tested in this study is that prepaid passes effect the riders' perception of the cost and boarding convenience of a transit trip and thus will increase transit usage. By allowing the rider to pay for some specified amount of transit service in advance, through periodic billings or through payroll deductions, the fare visibility is lowered, and, in the case of unlimited trip passes or when specific fare discounts are offered, the fare itself may frequently be lowered. If this results in increased trip frequency, vehicle productivities will be increased

with no change in level of service or vehicle operating policy. Additional benefits may accrue through time and cost of fare collection. A high usage of prepayment instruments reduces boarding times and improves the cash flow of the transit operator.

A state-of-the-art review of transit fare prepayment schemes has been completed. The study included the following tasks: survey ongoing and completed transit fare prepayment programs; identify the key features and problems associated with transit fare prepayment; measure and analyze public response to transit fare prepayment; assess the advantages and market potential of transit fare prepayment; analyze the cost-effectiveness of transit fare prepayment; and identify the best applications of and implementation structures for transit fare prepayment.

The study found that approximately 93% of U.S. transit systems have some form of fare prepayment, but most agencies do not have convenient distribution centers or effective marketing of the available pass options. There is a lack of data on various measures of effectiveness of fare prepayment plans. The judgment of transit operators is that prepayment plans, in general, increase ridership and probably never decrease ridership. Prepayment plans usually have no observable effect on revenue. Administrative costs, impacts on staff level, and impacts on coin handling and counting seldom appear to be significant. Most plans are reportedly used by only small percentages (less than 10%) of boarding passengers.

The transit user studies found that, among commuters, the choice of a transit payment method is based on a calculation of that user's expected cost per trip. However, economic considerations do not predominate among groups having limited incomes. The front end cost of a multiple-trip purchase may be a deterrent to its use by people with limited incomes.

The study concluded that employer-sponsored programs for distributing prepayment mechanisms have been effective and deserve more attention from transit operators. Another conclusion was that day passes may have significant, but largely undiscovered, advantages related to providing passenger convenience, encouraging offpeak travel and meeting the needs of low income users. The results of the study provided a potential for investigating further innovations with prepaid passes in marketing and distribution options.

Transit Service Improvements

As was mentioned earlier, pricing and service improvements present complementary strategies for the encouragement of high occupancy vehicle usage. Work in the transit service improvement area has included a study of short-range transit improvement, the development of attitudinal measurements for the evaluation of transit improvements, and a mode choice modelling effort.

Short Range Transit Improvement Study

In the study of short-range transit improvement, the principal questions for research are concerned with the existence and magnitude of various possible outcomes from short-range improvements. Broadly categorized, these outcomes relate to the demand for transit service, to the quality of service experienced by the user, to operating costs, to other impacts on the transit industry, to impacts on urban transportation, and to other longer-term considerations.

The study explores the appropriateness of four different general research activities to appraising the most important of the potential outcomes. These four activities are the analysis of existing transit operating experience, with and without the collection of new data, and the mounting of social experiments, either in a "real world" operating environment or else in some simulated setting. In each of the general categories certain specific research studies are concluded by placing priorities (which are partially subjective) for federal support on the thirteen different research studies proposed.

Attitudinal Measurement Study

An effort is ongoing to determine effective attitude measurement techniques for transportation planning and evaluation. Work has begun to define the utility and appropriate applications of attitude measurement techniques for transportation planning and evaluation. This eighteen-month effort, which concludes in January 1978, will produce a manual for transportation planners and operators referencing attitude measurement applications and a final technical report detailing the validity of attitude measurement techniques for predicting travel behavior.

It is necessary to use multiple approaches to investigate the utility and validity of attitude measurement. The starting point is a survey, analysis, and synthesis of issues in and procedures for attitude measurement as developed in social science and market research. Based on this integration of potentially useful procedures, a research design has been formulated suggesting ways to incorporate attitude measurement techniques in SMD evaluations. The goal of the research design is to understand the evolution of market awareness of and interest into the use of the transit service change. There will be a technical report on the validity and forecasting accuracy of attitude measurement techniques.

Findings to date suggest that attitudes predict behavior if behavior is simple, if specific and concrete questions are asked, if service attributes are measured, if respondents are stratified into homogeneous groupings according to demographics or attitudes, and if there is a shorter time interval between the measurement of attitude and behavior. Recommended measurement techniques include semantic differentials, subjective probabilities and tradeoff analyses.

Attitudes should be measured through preference, satisfaction, modal attribute importance, service awareness, and behavioral intentions data. Mode choice is a useful analytic focus in trying to establish the utility of attitude measurement and choice constraints ought to be measured as part of the travel data base. It is also necessary to simultaneously gather aggregate and disaggregate travel behavior data. Respondents should include users, both regular and intermittent, and non-users, as well as users of other transit services.

Mode Choice Modeling

A fully competitive mode choice model has been calibrated and validated using data from the Shirley Highway and I-35W in Minnesota. The study had two objectives. The first was to determine and isolate those factors which influence the switch from auto to bus ridership, assess their relative importance, and determine how they combine to produce the bus market share. The second objective was that the first objective should be satisfied in a fashion that would allow the results to be transferred and applied to other areas.

The Shirley Highway, which connects suburban Northern Virginia to Washington, D.C., has two reversible exclusive lanes for express buses that extend a distance of eleven miles. Within the District, peak period bus lanes and special turn advantages give the buses some priority over autos.

Using Shirley Highway data from 1971, several calibrations were performed using various model structures. From these, several fully competitive models were calibrated. A fully competitive model is one in which the comparison between two alternative mode choices is influenced by what other alternatives are available. Price and time elasticities for several of the models were computed.

A data base similar to that of the Shirley Highway was developed in 1974 as part of the I-35W Urban Corridor Demonstration Project in Minneapolis, MN. The main features of the I-35W project include exclusive bus ramps providing priority transit access to the freeway and the metering of traffic entering an urban radial freeway. This data base was used for model calibration in order to explore the transferability of the Shirley Highway binary mode logit model structure to another urban region, and to develop an n-dimensional logit model and corresponding fully competitive auto-occupancy model on the I-35W data for subsequent comparison with the 1974 Shirley models. These models allowed for several modes: transit, drive alone, carpool driver, and carpool passenger.

The calibration phase provided some empirical support to the intuitive expectations that modal choice is related to auto and bus costs and travel times. Whether an individual accesses a bus via auto is also related to modal choice insofar as the necessity of having to use an auto connector is a deterrent to transit use.

SIMULATION FOR TRAFFIC MANAGEMENT STRATEGY ANALYSES

The national concern with the impact of transportation on the environment, the slowing of major roadway construction, and the increased demand for mobility make it imperative that our transportation capability be used in the most efficient and responsible manner. To this end, optimal traffic management strategies must be developed and implemented. The development of candidate management strategies includes a prediction of the impact of the recommended strategy on the traffic system prior to

impelementation. The movement of traffic on city streets and highways is an extremely complex system. A change in the operation of a single traffic signal can alter the flow in the entire network. High speed digital computers are ideally suited for the analysis of traffic networks and can be used to simulate flow and determine performance measures for a wide variety of traffic management strategies.

Computer models SCOT (Simulation of COrridor Traffic) and its extension STRAP (Simulation of TRaffic for Analysis and Planning) are being used as laboratory test beds for the evaluation of candidate traffic control strategies prior to field demonstration. These models contain logical relations which are realistic descriptions of the way vehicles move through urban streets, highways, and freeway corridors. The data required to calibrate the models to the proposed field site include area geometry (e.g., street spans, number of lanes per street, intersection configuration, parking lot locations), traffic demand (e.g., inflow rates with truck percentages, intersection turning movements or origin-destination volumes, pedestrian counts), control functions (e.g., traffic signal timings or actuated traffic signal logic, restricted streets or turning movements, ramp metering logic), and bus service (e.g., routes, headways or schedules, and bus stop locations, capacities and service time distributions). These observed data model the field site traffic environment. The computer model then proceeds to simulate the movement of vehicles through the network in a manner consistent with their observed behavior at the field site. Trucks and buses occupy more space than passenger automobiles and accelerate more sluggishly. All vehicles accelerate, cruise, change lanes, decelerate, join queues, maneuver through intersections and stop for traffic signals. There are ten driver types ranging from conservative to reckless, and therefore, a variety of driving patterns are replicated. Buses are moved through their routes at the prescribed headways or schedules, serving passengers at scheduled stops and, when appropriate, preempting traffic signals. After a stipulated simulation period, performance measures are aggregated from the individual vehicle trajectories. These include such quantities as number of vehicle miles and vehicle minutes, delay time, average speed, average number of stops per vehicle, average occupancy (in vehicles) for each street and for the entire network. Thus, congested streets may be identified. Bus performance measures are displayed separately and include delay time and number of stops on each street, times and duration of bus stop overloads and bus route travel times, passenger service times and average speeds. Important congestion conditions are also

identified. These are locations of cycle failures (inability of the green phase to discharge an entire queue) and locations and durations of spillback (queues blocking an intersection).

Several bus operation strategies have been evaluated by the Transportation Systems Center using computer simulation. Plans were made in Minneapolis to install 20 mid-block pedestrian crosswalks and traffic signals to improve service on the new contraflow bus lanes. Since the timing of these signals would be synchronized with those at the intersection, minimal impact on traffic flow was anticipated. The simulation study showed, however, that the average total delays on these streets would increase 25% for general traffic and 8% for buses using the current simultaneous signal timings. If progressive traffic signal timings were installed, these average delays would still increase: 8% for general traffic and 15% for buses. Consequently, the plan to install these mid-block traffic signals, at an estimated cost of $400,000, is under reconsideration.

The preemption of traffic signals by buses in the contraflow lanes in Minneapolis was also analyzed by simulation. The preemption logic includes a request for an extension of the green phase or a truncation of the red phase by buses approaching an intersection after picking up or discharging passengers. The granting of such a request is based upon the completion of a minimum green phase for the cross street and the evaluation of net delays. Preliminary results show that the average delay of buses in the contraflow lanes decreases 20%. The average delay of general traffic, however, increases 18%. If there are 40 passengers per bus and 1.3 passengers per car, the net decrease in person delay is 6%. The break-even point in delay occurs if there are only 16 passengers per bus.

The design of traffic signals timed to the speed of buses was made using computer model SIGOP and the evaluation of this design was made using SCOT. The history of the use of signal synchronization has been to permit general traffic to progress at about 25 mph moving with the green band. Such a design does nothing for the much slower movement of buses. This study provided buses with a progressive pattern. The results show an average decrease in bus delay of 23%. General traffic pays for this improvement with an increase in delay of 21%. The net gains are similar to those expected from the signal preemption strategy. (Similar results have been observed in the actual operation of buses under signal progression in the Miami demonstration

project described in Chapter 2). The cost of the installation of a bus progressive signal system is simply the cost of changing the signal timings. If further study confirms that the benefits may be as large as those incurred using the much more costly preemption system, an extremely important bus priority strategy may be available to both small and large cities.

Computer models SCOT and STRAP have two options for the input of traffic demand. The first method moves vehicles through the network according to entry point in-flow rates and intersection turning movement statistics. The second method specifies origin-destination volumes. The model then determines the current optimal path joining these endpoints. The objective function is a linear combination of time and distance, and it is minimized for each vehicle. This second method is preferable in evaluating candidate bus priority strategies because it permits general traffic to adapt to the priority strategy and determine the best route.

Two preliminary simulation studies were made to evaluate the bus preemption strategy on a Minneapolis network. The first study used the former option for the definition of traffic demand, i.e., observed entry point in-flow rates and intersection turning movements. The results showed that when drivers maintain their driving patterns in spite of changes in the control system, they incur an increase in delays of 18% when the bus preemption strategy is in effect. The latter study used the second option for the definition of traffic demand, i.e., observed origin-destination volumes. The results showed that when drivers change their driving patterns in order to adapt to the prevailing control system, they incur an increase in delays of only 11% when the bus preemption strategy is in effect. Thus route optimization can decrease general traffic delays significantly.

The origin-destination traffic demand option also provides the optimal traffic assignment for the traffic conditions and control system prevailing. It thus determines the upper bound of the system performance for the proposed control and the specified traffic demand. This upper bound identifies the amount of improvement possible and is very important in deciding whether an optimal or sub-optimal system is cost-effective and which should be implemented.

TRANSIT SERVICE RELIABILITY STUDY

An analytical study is being conducted on the nature and causes of transit service reliability problems, possible improvement strategies, and the potential benefits to travelers and providers of improved service reliability. For the purposes of this study, service reliability has been defined as the invariability of level of service attributes including, but not limited to, travel time and its component.

There are several reasons for the initiation of this study. First, improvement of transit reliability is a major objective of the SMD Program and is also intimately related to other SMD objectives, such as improving travel time and increasing productivity. Second, it is likely that service reliability is crucial in influencing both the demand for transit and the costs of providing transit service and thus of major impact on ridership and revenues. Finally, reliability and perceived reliability are considered to be of particular importance in the design of innovative transit services.

The goals of this study include; (1) the fostering of transit reliability improvements through the dissemination of new awareness of the role and importance of transit reliability; (2) the identification and development of improvement strategies that can be demonstrated; and (3) the improvement of the measurement and evaluation of reliability in complex demonstration settings. Although this study is not yet complete, some tentative findings can be offered.

Attitudinal studies have indicated that reliability is considered to be an important determinant of travel choices. Conceptually, in planning trips, travelers may be thought of basing their behavior not only upon the average values of relevant service characteristics, but also on the variability of these characteristics. For this reason, the reliability of travel alternatives will potentially influence trip frequency, destination, mode, and route choice. Reliability may also be a strong determinant of travel behavior once these basic travel choices have already been determined. For example, when it is necessary for travelers to reach destinations by a particular time, most travelers will base their departure times on both average travel times and travel time variability.

Preliminary analysis suggests that transit reliability improvements will tend to reduce average transit wait times and in-vehicle travel times as well as their variability and

will enable many travelers to obtain travel time savings. Significant improvements in transit reliability may also encourage users of other modes to switch to transit.

Transit operators typically view unreliability in terms of aggregate system performance (e.g., adherence to schedules) and view unreliability as a system characteristic which increases the cost of providing service. This is because the operator must allot greater amounts of slack time or layover time to counteract the probabilistic nature of transit service. Improvements in reliability, therefore, are likely to benefit transit providers through a reduction in the vehicle-hours and driver-hours required to produce the same amount of service, or through an increase in the amount of service that can be provided with the same expenditure of resources.

Specific causes of unreliability in transit service apart from vehicle reliability problems have been found to be inherent in the transit service concepts as well as the result of exogenous factors. Examples of the concepts inherent in unreliability include the basic instability of fixed-route services in terms of headway, i.e., the tendency of buses to cluster and bunch as they proceed along a route, and the inherent variability associated with dynamic routing in demand-responsive systems. Similarly, exogenous factors such as traffic lights and traffic congestion are strong determinants of service reliability.

A variety of strategies have been identified for improving reliability. These include priority techniques such as exclusive lanes, signal preemption, and merge/freeway access. Operational strategies may entail reserve fleets and drivers, modified service frequencies, express service, improved schedule planning, payment schemes, computer dispatching, as well as other service changes. Lastly, bus control strategies include holding, passing, turnback, skip stop, and speed modification. While all of these strategies offer promise, further research is needed to determine which strategies are most cost-effective. Limited results to date have shown control strategies to be very effective when applied at terminals and a limited number of bus stops. Many can be implemented at little cost.

RESEARCH ON THE TRANSPORTATION PROBLEMS OF TRANSPORTATION HANDICAPPED INDIVIDUALS

The overall objective of this research project is to determine the travel requirements of various classifications of transportation handicapped people and to develop viable transportation service alternatives utilizing all modes which can satisfy such requirements cost-effectively. The central issues being addressed are to define who is the transportation handicapped person, what are the problems on current transportation systems, and what solutions might be available for the locality to use in remedying this situation.

The project covers all urban modes: mass transit, auto, and taxi. The inter-urban bus and rail interface with the urban modes is also treated. Air travel and interurban services are excluded from this research. Travel within rural areas will not be covered. Any demonstrations of service or equipment improvements designed or recommended will not be implemented as part of this project.

The project will develop classifications for transportation handicapped persons and identify the number, demographic characteristics, travel patterns, and travel requirements of all classifications. A cost/benefit analysis will be conducted to evaluate alternative approaches for meeting the transportation needs identified. Demonstrations will be designed in typical urban environments to implement or test proposed solutions. Minimum standards and guidelines will be developed for the alternative service and equipment improvements recommended and a manual for planning transportation improvements for transportation handicapped persons will be produced. A suggested national program, including its cost, for improving the urban mobility of transportation handicapped persons will be described. Finally, the Section 5 requirement of the UMTA Act was investigated.

A major task of this project, the recent national survey of transportation handicapped individuals, was administered and data from this survey is now being tabulated and analyzed.

An inventory of half-fare practices for elderly and handicapped has been taken, and case studies of ten cities with half-fare programs have been performed. Reports on these two efforts are available through NTIS.

Preliminary to the national research effort, a report in four volumes has been published that includes the following topics: the transportation handicapped population, definition and counts; the roles of government and the private sector in the provision of mobility systems for the transportation handicapped; alternative planning methodologies; and transportation solutions for the transportation handicapped. These volumes represent a state-of-the-art review of the situation and is a compilation of information provided to UMTA by three separate contractors.

DEMAND-RESPONSIVE TRANSIT PATRONAGE MODEL

In the past, public transportation officials have tended to concentrate their planning and design efforts on fixed-route rail and bus systems. However, the combination of shifting residential densities and the desire for public transportation to serve a wider spectrum of travel needs has focused increasing attention on demand-responsive transportation (DRT). Such transportation systems are in reality a wide range of possible service options that have one commen element; they respond to the demands of passengers both in terms of where and when they wish to travel.

A critical problem local planners face when they attempt to design DRT systems is the difficulty of forecasting future patronage; many of the major decisions on capital outlays such as the number of vehicles purchased depend on expected ridership levels. In response to this need for planning methods, a study entitled, "A Method for Estimating Patronage of Demand-Responsive Systems," has developed a computer-based procedure intended for use by local planners which will predict DRT patronage.

The patronage forecasting procedure consists of three basic modules: work trip and non-work trip demand; a level of service prediction capability; and an equilibration procedure (see Figure 2). The model explicitly treats the quality of service provided by the DRT system as a determinant of expected patronage. Conversely, the model also represents the fact that the quality of service provided by the DRT system itself depends on the patronage. The final forecast is therefore the ridership level and service level which simultaneously satisfies these two basic relationships.

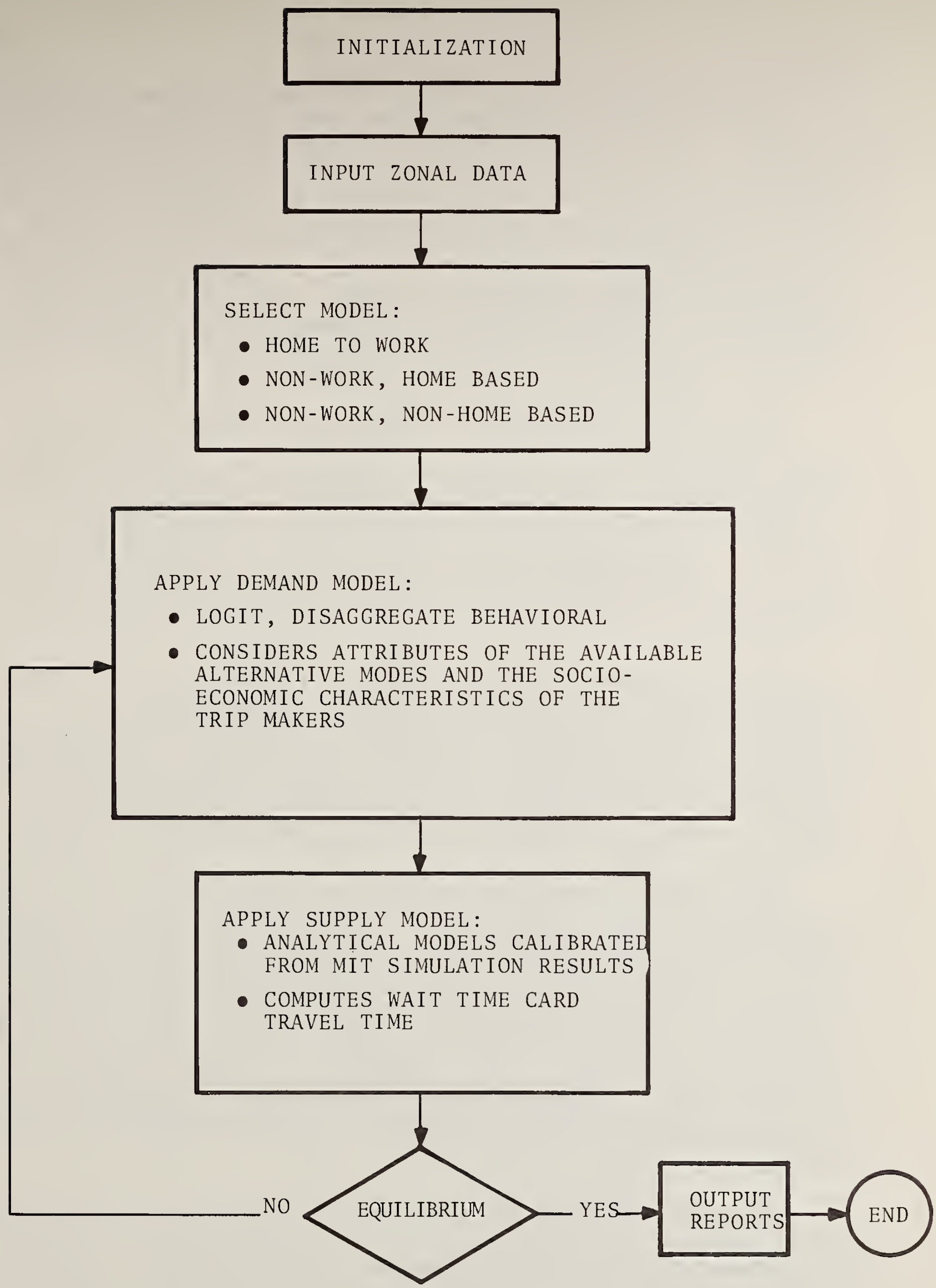

FIGURE 2. FLOW DIAGRAM OF DRT PATRONAGE MODEL

The patronage prediction procedure requires as inputs a description of the intended service area, current work trip patterns, the characteristics of the served population and the major design choices such as the vehicle fleet size, the changes in fleet size over the day, the type of vehicles being used (buses or taxis), and the fare level. Using this data, the model predicts patronage and service levels for each user-specific interval during the day. By testing alternative configurations of fleet size, vehicle type, service area and fare level, the planner can explore the impacts of a range of alternative designs and predict the tradoffs inherent in changing the system design.

The work and non-work travel demand models rely on disaggregate choice theory, a relatively new methodology which considers the decisions individual travelers make when confronted with a set of possible tripmaking alternatives, one and only one of which is selected. These models represent the current state-of-the-art in travel demand modelling and provide for a much more complete and realistic description of tripmaking behavior than more traditional procedures.

Both the work and non-work travel prediction submodels were calibrated using data from two urban areas, Haddonfield, New Jersey, and the SMD project in Rochester, New York, both of which had ongoing DRT systems at the time the data were collected. Model specifications tested on the Haddonfield data permitted later efforts with the more complete Rochester data to be significantly more focused.

The level of service prediction component of the model was developed by using information from a detailed computer simulation of DRT operations. This simulation was developed at MIT and was validated on the Haddonfield, New Jersey, DRT system. Using data generated by executing the simulation to forecast DRT service quality under a wide range of operating conditions, sets of equations for predicting expected wait time and travel time, were developed. These equations are sufficiently tractable so that they can be used separately from the computer-based procedure as simple planning tools. Possible outputs from the supply modes are illustrated in Figures 3 and 4.

The entire patronage prediction procedure is currently being validated by applying it to two other urban areas with DRT systems, La Habra, California, and Davenport, Iowa. These cities are quite different from the cities used for calibrating the model and, therefore, present a major test for the forecasting procedure. For example, the Davenport

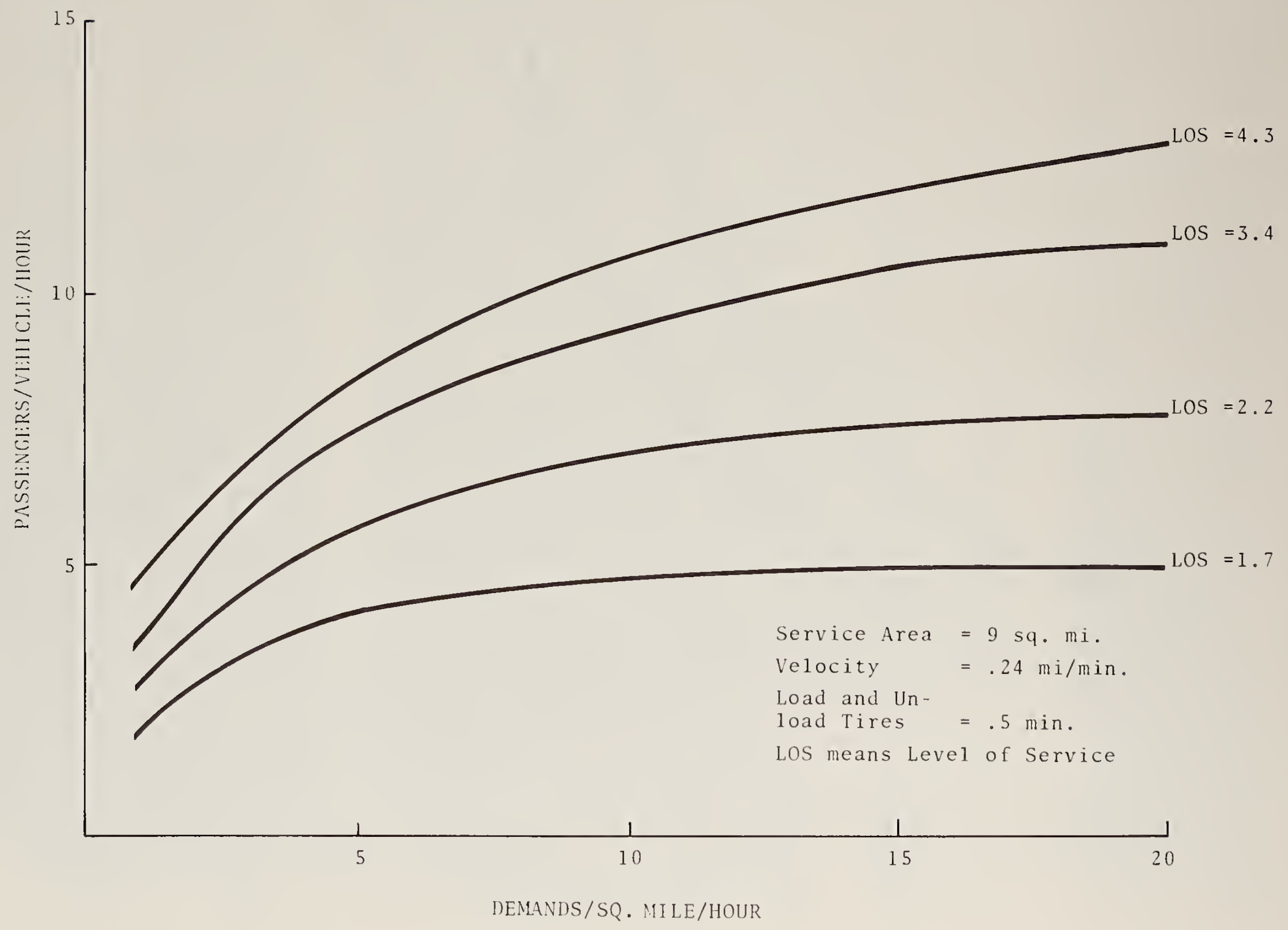

FIGURE 3. PRODUCTIVITY VS. DEMAND DENSITY

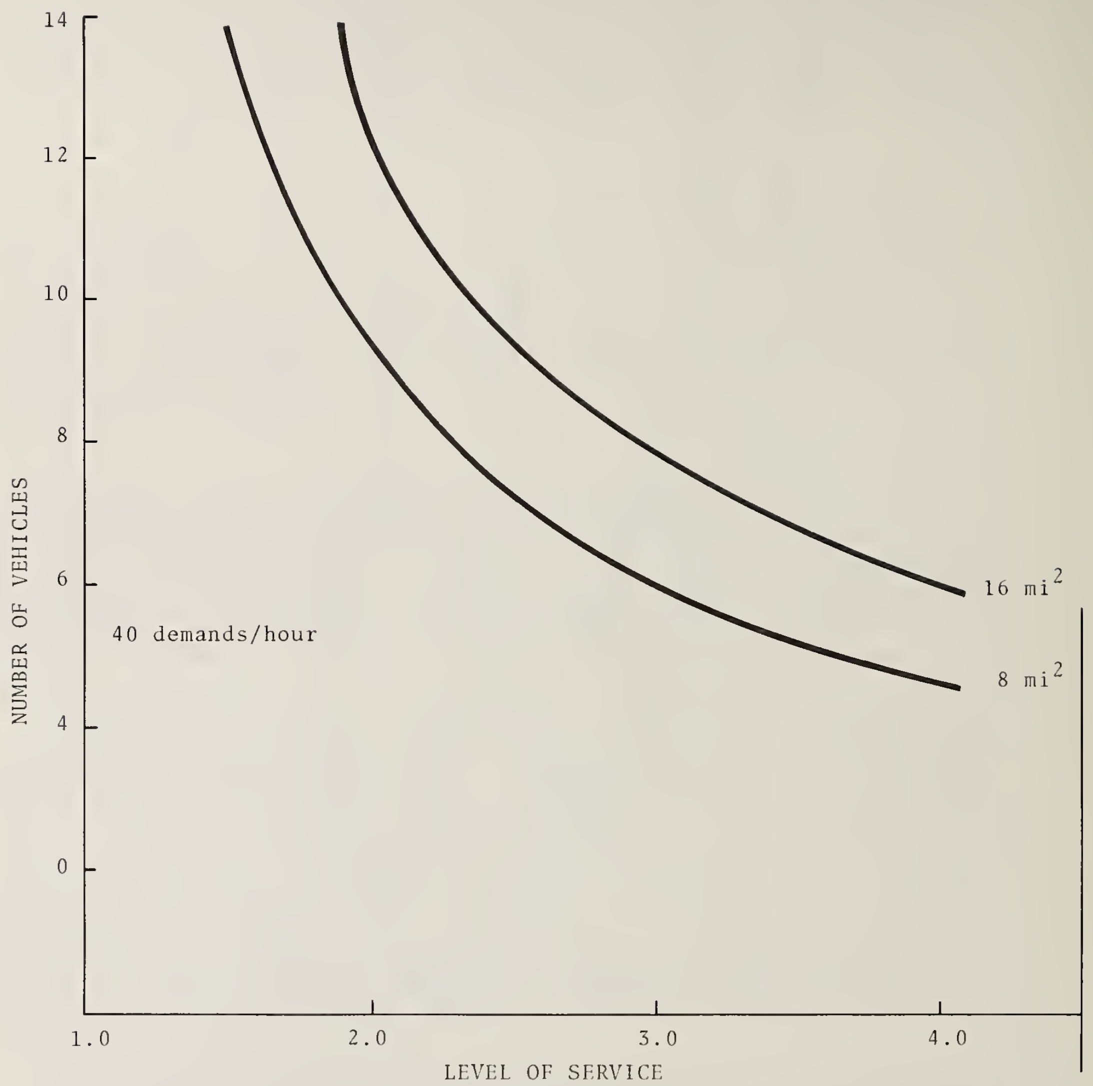

FIGURE 4. VEHICLE FLEET SIZE VS. LEVEL OF SERVICE

system uses taxis and charges fares that are a factor of two to three higher than those charged in Rochester, which relies on buses.

Recognizing that many agencies will not have the staff and resources to implement and use the above highly detailed model, a simplified "sketch planning" model is also being developed. This non-computer oriented patronage forecasting method is a set of curves, or nomographs, that are derived from the more complex computerized model system, but require nothing more than some simple descriptions of the service area and DRT system to use.

AUTOMOBILE RESTRICTED ZONE FEASIBILITY STUDY

An eighteen-month study to evaluate the feasibility of the automobile restricted zone (ARZ) concept and to develop initial demonstration designs in several selected cities is nearing completion. An ARZ is an area created in a congested portion of the city, such as the central business or shopping district, where automobile traffic is prohibited or restricted. Such a zone may range in size from a few blocks along several adjacent streets to large portions of major activity centers. There are many forms of automobile restricted zones: an ARZ might be created through the imposition of severe parking restrictions, barriers to through traffic, or a ban on all automobiles. An automobile restricted zone is expected to lead to a reduction of transit travel time and an improvement in transit reliability since transit vehicles will no longer be impeded by automobile congestion. In addition, an ARZ could lead to increased transit usage, decreased land requirements for parking, and decreased pollution, energy consumption, and accidents. All this would help to provide a more appealing environment for pedestrian oriented activities on or adjoining the street.

At present, over 70 American cities of varying sizes have instituted some form of auto restriction. The technique predominantly utilized has been the closure of the downtown shopping street and its conversion to a pedestrian area with a high degree of emphasis placed upon improved urban design features. More recently, a number of cities have been moving toward a more comprehensive approach to traffic reorganization, transit emphasis, and environmental improvement. The ARZ concept takes on the added dimension and within the European context there are over 130 cities that have instituted this form of auto restriction. The larger ones have included major transportation-related

elements such as minibus-type services, better regular transit service, special transit facilities, additional parking garages, and traffic operations improvements.

The following conclusions about ARZ planning and implementation have been reached: there are substantial opportunities for ARZ's in American cities; city-size is not critical to ARZ success; a strong activity base is required; a wide range of techniques are available; the complete prohibition of auto traffic is not the only option; ARZ size is a key determinant of transportation impacts; and the key transportation factor is maintaining accessibility.

Results from this study have been used to select prospective ARZ sites and to develop initial plans for demonstrations. This is discussed in Chapter 2.

MULTI-USER VEHICLE SYSTEM FEASIBILITY STUDY

The purpose of this study was to explore the feasibility of using a form of urban public transportation, the multi-user vehicle system (MUVS), for internal person movements within an urban area. The distinguishing characteristics of MUVS is the provision of small user-operated vehicles for use between a set of fixed but relatively ubiquitous terminals in an identified service area. The possible variations in vehicle design and operating environment are numerous. But in all cases the characteristic that sets MUVS apart from other forms of conventional and paratransit services is that the user serves as the vehicle operator. The potential cost savings from reducing the labor-intensity of public transit services is apparent when one considers that labor comprises approximately one-half of bus operating costs and an even greater percentage of taxi operating cost. Other potential benefits of MUVS include its low energy consumption, minimal pollutant production and small size relative to the private auto, and its convenience relative to conventional bus services.

Although MUVS, broadly defined, has been widely used in a variety of special applications (e.g., shopping carts and short-term rental vehicles), operating experience with MUVS as a circulation system in urban areas has been limited. In the few isolated cases where MUVS has been employed in urban areas, the systems have either failed outright on financial grounds or maintained operations on an extremely small-scale basis without generating sufficient demand to be seriously considered as a viable and vital urban transport service.

In light of the limited success with MUVS to date, the first task of this analysis was to perform a critical appraisal of existing experience with MUVS city circulation services. The intent was to determine whether the limited success with MUVS urban circulation services to date was indicative of inherent weaknesses with the MUVS concept or whether the failures could be attributed to isolated factors which could be overcome in future demonstration projects. This appraisal concluded that neither of the two experiments with MUVS to date (Montpelier, France, and Amsterdam) provided conclusive evidence on the ultimate viability of MUVS. In both instances, a variety of unique and potentially correctable institutional and system design factors limited the acceptability of the systems. However, based on an analysis of key factors required to make a successful MUVS demonstration, it appears unlikely that MUVS is a viable and promising modal alternative for intra-CBD service or without auto restrictions. There are four basic reasons for this conclusion:

1. Unreliability of service. Even with relatively large fleet sizes, stochastic variations in customer arrivals and systematic diurnal and directional demand peaking within the service area lead to potentially long vehicle wait times. The variance in customer wait times is also extremely high.

2. Low system utilization. Even assuming zero terminal (turnaround) requirements (for refueling or recharging MUVS vehicles), analyses consistently showed fleet utilization rates to be 15% or less. Thus for the great majority of time, MUVS vehicles would sit idle at terminals.

3. Potentially large fleet size and terminal requirements. In order to provide a MUVS service which competes with the door-to-door convenience of taxi (or possilbly private auto), terminal densities on the order of over 100 per square mile may be required. The fleet size requirements to avoid inordinately long wait times are extremely sensitive to the directional and diurnal peaking characteristics. In all of the analyses, even with fleet sizes as high as one vehicle per 12.5 person-trips in the service area, temporary vehicle unavailability at selected terminals persisted for as long as a half hour.

4. Potentially high system cost. In view of the above conclusions, capital costs per trip are very high. Operating costs may also be high relative to alternative modes. Even if "human-powered" vehicles were deployed, implementing a vehicle redistribution policy to mitigate the effects of directionally peaked demands requires the repositioning of a large number of vehicles with correspondingly high labor costs. Our analysis of one vehicle redistribution policy required "deadheading" trips equal to 12% of revenue trips. Moreover, even with high vehicle repositioning during the course of the day, vehicle unavailability at selected terminals remained a critical factor.

SHARED-RIDE AUTOMOBILE FEASIBILITY STUDY

A significant effort has been made in the last several years to increase the use of various types of pooling including carpooling and vanpooling. However, many of these efforts have met with only limited success. The single occupant auto remains the predominant mode of travel for all types of trips. The overwhelming majority of people prefer their single occupancy cars for a variety of reasons, particularly convenience and flexibility.

One method of group auto travel, however, has received little attention in the past. This approach, referred to as shared-ride auto, would use individual commuters and their own vehicles to carry riders for a fare from a specified residential area to a specified employment area and return. Unlike a traditional pooling arrangement, the vehicles would be permitted to pick up any rider desiring to travel in the designated direction. The system would have neither predetermined riders nor departure times. Unlike conventional transit, shared-ride auto would not operate on a fixed schedule, and unlike a jitney-type service, the drivers would not necessarily work full-time.

There are currently several barriers to implementing this type of operation. Legal and institutional questions must be addressed, as well as problems of insurance, maintenance standards, passenger and driver security, and service reliability.

A study will be conducted to explore the operational feasibility of shared-ride auto. This study will expand the description of the concept to delineate thoroughly all

operational facets and analyze all institutional factors which may affect implementation of the concept.

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CHAPTER 8

INFORMATION DISSEMINATION

INTRODUCTION

Innovative transit demonstrations must be well documented and widely distributed if communities with transit problems are to make intelligent choices. Further, it is crucial that the data be structured so as to be transferrable and understandable to the responsible officials in other urban areas. Channels and mechanisms for disseminating such information are being developed. Products and findings are aimed at a variety of audiences, including transit planners, operators, and city officials. Conventional as well as new channels of communication are being considered and evaluated for their suitability.

The Service and Methods Demonstration Program currently uses several methods for disseminating information. The major communication media and channels for dissemination of SMD program findings are listed (not in any priority order) here with a more detailed description following.

- The Urban Consortium
- Documents
- Site Visits
- Seminars and Workshops
- Conference Presentations
- Audio-Visual Products
- Information Banks

THE URBAN CONSORTIUM

The Urban Consortium for Technology Initiatives was formed by 34 of the largest urban governments to identify, to give priority to, and to encourage technological assistance for the most pressing urban problems. It operates with administrative assistance of Public Technology, Inc., itself formed by the five large national organizations of local governments and officials.

The Consortium, through a careful screening process, developed a list of urban needs using several meetings of all members as well as questionnaires. These needs were subsequently broken down into nine areas, such as transportation, energy, and public health. A task force was

formed for each subject and is proceeding to study, find funds, and develop solutions for the needs as identified by the Consortium.

The Consortium's Transportation Task Force has considered some 94 needs and reduced the number to 10 of the highest priority, e.g., transportation for the elderly and handicapped and transit system productivity.

The Service and Methods Demonstration Program is contributing to the reports made available to the Consortium, such as the Manual for Implementing Priority Techniques for High Occupancy Vehicles: Executive Summary; Management Report; and Technical Guide. This and other reports generated from SMD project findings are communicated to the Consortium members. These members comprise an important segment of the potential users of innovative transit data.

It is essential for the SMD Program to maintain close contact with the Consortium because it represents urban areas with pressing transportation issues and transit needs. In this way, the program can stay abreast of those needs in initiating research or selecting demonstration sites.

DOCUMENTS

The SMD Program publishes a number of documents and also contributes to industry publications in an effort to disseminate findings of the program. These consist of the following publications or types of publications:

1. The Annual Report summarizes in a rather detailed manner the new and continuing activities of the Program.

2. Project evaluation reports are detailed reviews and assessments of individual demonstration projects.

3. Evaluation Guidelines for Service and Methods Demonstration Projects (see Chapter 5) is intended to foster consistency of evaluation philosophy and techniques, and comparability of results. In addition to containing procedures for planning and executing the evaluation of SMD projects, it contains a general discussion of the demonstration evaluation process, and appendices on survey techniques and statistical methodology. Although

these guidelines were prepared specifically for evaluating SMD projects, their potential applicability includes the evaluation of any type of innovative transit project.

4. Case Studies of innovative or noteworthy transit operations which warrant dissemination. For example, case studies of 13 small community transit operations (described in Chapter 6) were conducted to better understand the current experiences and approaches to public transportation in small cities.

5. Results of analytical studies such as the impact of fare and service policies on transit ridership or concept feasibility studies.

In addition to published technical reports, SMD Program findings are also reviewed in transit industry publications and professional journals.

SEMINARS AND WORKSHOPS

Seminars and workshops are conducted to discuss technical results or assess needs and priorities for future development. The six regional seminars on small community transit (Chapter 7) provided a forum both for the presentation of case study findings and for the sharing of experiences in all aspects of public transportation for small cities. Previous workshops have dealt with applications of bus priority techniques and the utility of attitudinal survey techniques in transportation planning and evaluation.

CONFERENCE PRESENTATIONS

Various aspects of the SMD Program have been presented at a variety of conferences. SMD staff made presentations or participated in panel discussions at the following conferences during the last fiscal year:

National Transportation Conference on Improving the Quality and Quantity of Transportation for the Elderly and Handicapped, Orlando, Florida, December 1975.

Transportation Research Board (TRB), Washington, D.C., January 1976.

Organization for Economic Cooperation and Development, Paris, France, February 1976.

Annual Demand Responsive Transit Conference, Washington, D.C., March 1976.

Boston Transportation Group (American Society of Civil Engineers), Boston, April 1976.

TRB Special Conference on Urban Transportation Pricing Alternatives, Easton, Maryland, May 1976.

National Census on the Black Aged, Washington, D.C., May 1976.

Therapeutic Recreation Conference, Washington, D.C., May 1976.

Access V Conference, Chicago, Illinois, May 1976.

National Conferences of State Transportation Specialists, Hersey, Pennsylvania, June 8, 1976.

American Public Transit Association (APTA), Mid-Year Meeting, St. Louis, Missouri, June 1976.

Association of Washington Cities Convention, Spokane, Washington, June 1976.

National Automobile Dealers Association, Washington, D.C., July 1976.

Urban Transpo Efficiency Conference, Washington, D.C., July 1976.

Highway Users Federation, Washington, D.C., August 1976.

American Road Builder's Association, Jackson, Wyoming, September 1976.

International Downtown Executives Association, Chicago, September 1976.

Conference on Economic Regulation of Transportation, Annapolis, Maryland, September 1976.

DOT, Association on Aging (AOA) Coordination Conference, Boston, Massachusetts, September 1976.

AUDIO-VISUAL PRODUCTS

Slide presentations, films, and videotapes are an effective means of illustrating innovative transit concepts in operation, and in some cases, may serve as a substitute for site visits to demonstration projects. A film illustrating examples of four transit service concepts appropriate to small communities was produced as part of the small community transit study program. It was shown at the regional seminars and is being distributed through the UMTA regional offices and the Audio-Visual Division of the Office of the Secretary (U.S. DOT).

INFORMATION RETRIEVAL SYSTEMS

In an effort to maintain a comprehensive file on new and innovative transit applications in urban areas, an information retrieval system was developed at the Transportation Systems Center. The Transit Operations and Planning Status (TOPS) file is a computerized, fast access information source containing project location, a brief summary of the innovation, status, operating and funding agencies, cost, and information source. Each entry, then, is a concise summary of a particular transit project in a specific urban area. The file is maintained and updated on a regular basis, using as sources transit industry publications, Departmental news releases, and contacts with UMTA regional representatives.

As an adjunct to this information, the TOPS data base also contains a directory of transit service modes and operations within each urban area. Accessing this sub-file by city provides output data which includes transit operating agencies, primary transit modes, route miles by mode, population, population density, metropolitan and regional planning organizations, and current UMTA Capital and Technical Studies Grants.

Users can access TOPS at a computer terminal through the use of key words and simple conversational commands. For example, a user can obtain a list of all projects of a given type, such as reserved freeway lanes, or a list of all projects in a selected urban area. This permits perusal by type of innovation or by location, depending upon the nature of the inquiry.

The TOPS file should prove to be a useful tool for demonstration site selection and the dissemination of information among sponsors of similar projects. It will

also be available to DOT personnel, transit planners, and others in keeping abreast of new and innovative transit applications.

APPENDIX A

THE I-95/N.W. 7TH AVENUE BUS/CARPOOL SYSTEMS DEMONSTRATION PROJECT: MIAMI, FLORIDA

OVERVIEW

In Miami, Florida, a demonstration project is in progress, designed to evaluate peak period express bus service on two different types of highways, a major arterial and a freeway, which run parallel for the entire length of the demonstration corridor. Bus priority treatments, park-and-ride facilities, and bus/carpool lanes on the freeway are important components of the demonstration project. There are two phases of the project: Phase 1 is the implementation and evaluation of various bus priority methods on the major artery, N.W. 7th Avenue; Phase 2 is the implementation and evaluation of reserved bus/carpool lanes on the freeway, I-95.

The demonstration project provides express bus service between populous residential suburbs north of Miami and four major employment centers in central Miami. The project corridor, depicted in Figure A-1, is approximately ten miles long, extending from the Golden Glades Interchange south along N.W. 7th Avenue and I-95 to downtown Miami, the Civic Center, the Airport, and N.W. 36th Street.

The demonstration project, which began in the spring of 1973, entered Phase 1 of the actual operations (preferential bus treatment on the major arterial) on August 26, 1974. On March 15, 1976, after completion of bus/carpool lanes on the parallel freeways, express bus service was transferred and Phase 2 commenced. The demonstration will continue through March 1977.

Three levels of government are taking part in the operation and evaluation of the Miami I-95/N.W. 7th Avenue Bus/Carpool Systems Demonstration Project. At the federal level the participants are the Urban Mass Transportation Administration (FL-06-0006) and the Federal Highway Administration. At the state level the participants are the Florida Department of Transportation and the University of Florida. At the local (county) level the participants are the Metropolitan Dade County Commission and the Metropolitan Dade County Transit Authority (renamed the Metropolitan Transit Agency in October 1974).

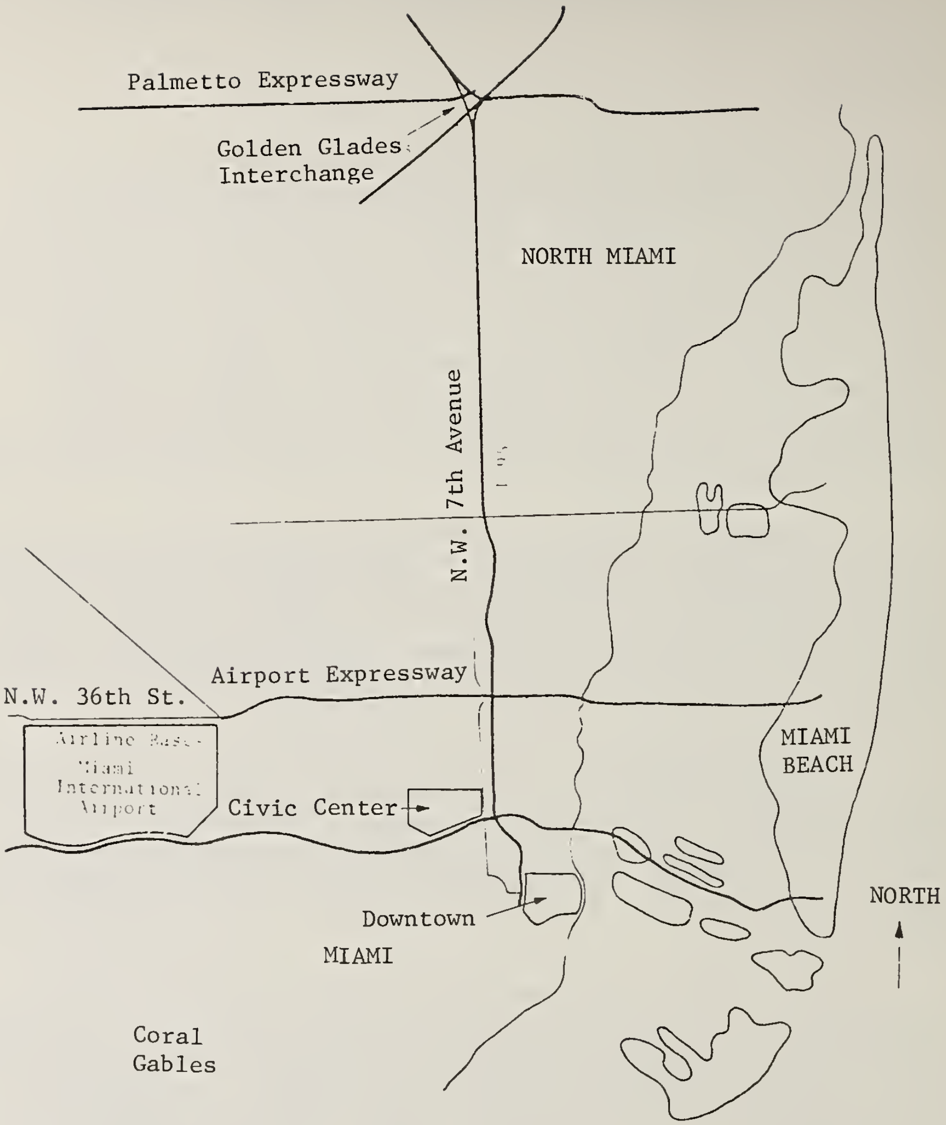


FIGURE A-1. PROJECT CORRIDOR, I-95/N.W. 7TH AVENUE, MIAMI, FLORIDA

Funding for the demonstration project is shared as follows:

Local/State	$ 3,393,000
FHWA	20,205,000
UMTA	3,500,000
TOTAL	$27,098,000

OBJECTIVES

The amalgamation of related transportation improvement strategies which comprise the Miami express bus/carpool concepts are intended to further the following objectives of the Service and Methods Demonstration (SMD) Program:

- To reduce trip time for transit travelers
- To increase transit reliability
- To increase transit coverage
- To increase transit vehicle productivity

In particular, the Miami demonstration project emphasizes the objectives of reducing trip time and increasing transit reliability. The various preferential strategies for buses on N.W. 7th Avenue and the reserved bus/carpool lanes on I-95 will result in decreased travel time and increased reliability (decreased variability in travel time) by virtue of the physical and/or operational separation of buses from the rest of the traffic stream. These travel time and reliability improvements will not only benefit the existing transit users, but should also divert additional commuter trips in the project corridor from low occupancy autos to express buses and carpools, thereby reducing congestion in the corridor and saving travel time for transit and auto users alike.

The Miami project serves to expand transit coverage by provision of park-and-ride facilities at the Golden Glades Interchange and new express bus service in the corridor. The objective of increasing transit vehicle productivity is expected to be accomplished via the decreased travel time, increased reliability and anticipated ridership increases.

At the local level, the Miami project has four primary objectives:

- Improve the passenger carrying capacity of N.W. 7th Avenue and I-95

- Encourage the use of public transit

- Demonstrate alternative surveillance, detection, and control systems to improve travel times by public transit

- Identify the impact of these system changes on the rider, operator, the public and industry.

Because of the national significance of the demonstration project, a comprehensive evaluation is being carried out. The evaluation study serves as a tool for measuring the effectiveness of the demonstration project, the extent to which it meets SMD and local objectives, and the degree of public acceptance. It is expected that the evaluation methodologies developed for this project may be applied to similar projects throughout the nation.

PROJECT DESCRIPTION

The basic strategy of the I-95/N.W. 7th Avenue Bus/Carpool Systems Project is to provide improved peak period service for bus/carpool commuter trips between residential suburbs to the north of Miami and major employment locations in central Miami. The project involves the provision of express bus ("Orange Streaker") service using two operational procedures: (1) various combinations of bus priority treatments on an arterial highway, N.W. 7th Avenue; and (2) reserved bus/carpool lanes on a parallel freeway, I-95.

Figure A-2 is a map of the ten-mile long project corridor and market area. The parking facilities located at the Golden Glades Interchange (the confluence of five major highways) constitute the northern end of the corridor, with the parallel portions of N.W. 7th Avenue and I-95 leading to the downtown, the Civic Center, and the Airport.

The project market area (delineated with a heavy line in Figure A-2) extends to the east, north, and west of the Golden Glades Interchange through northern Dade County and southern Broward County. Relevant information on the area is presented below:

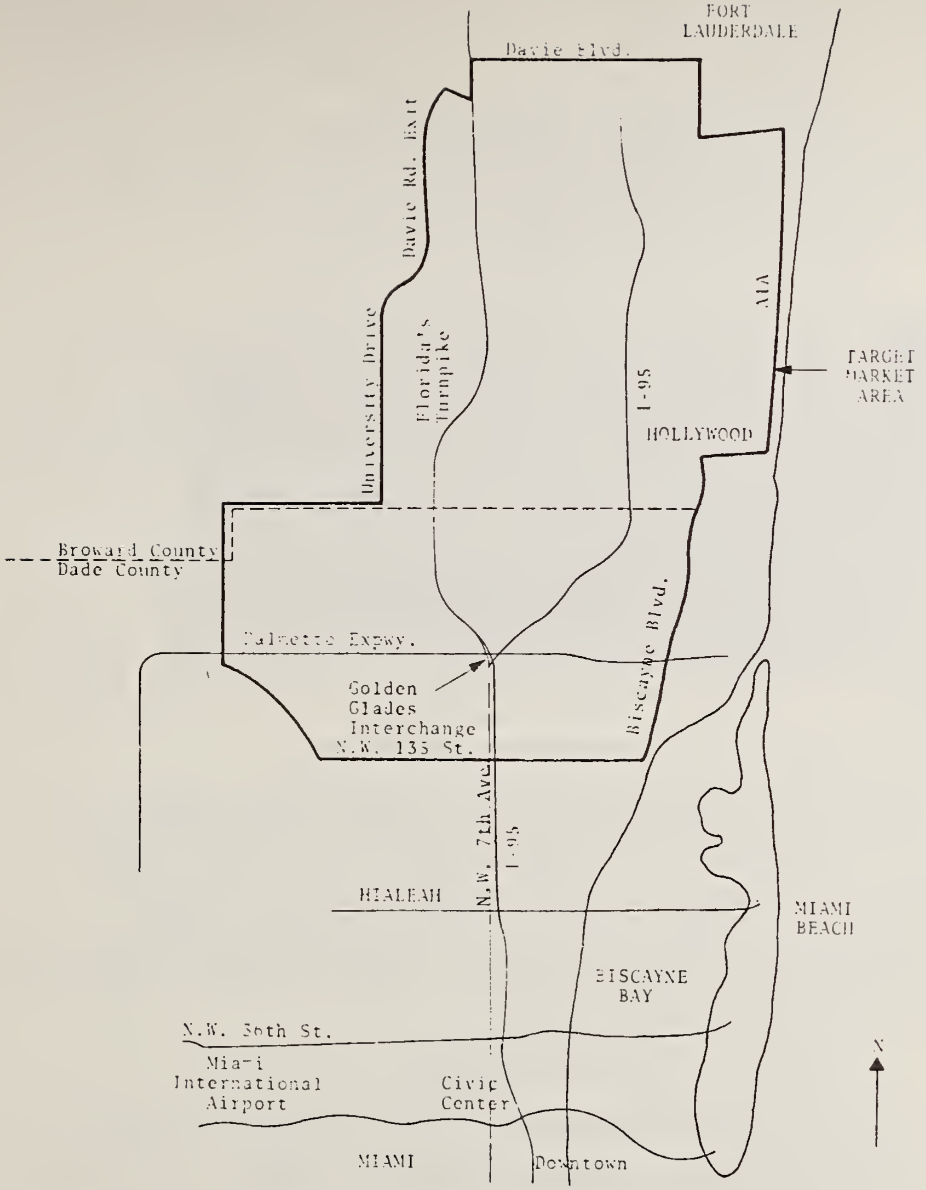


FIGURE A-2. TARGET MARKET AREA, I-95/N.W. 7TH AVENUE, MIAMI, FLORIDA

Land area	125 square miles
Population (1970)	385,000
Density (1970)	3,080 person/sq. mi.
Employment (1970)	137,000
Median income (1970)	$9,600
Average auto ownership	1.5 cars/household
Transit modal split	2-5%

The area consists mostly of single-family dwelling units with some apartments. Transit service is radially oriented in a north-south direction and consists of local and peak period express bus service. The local bus service in the corridor has remained unchanged (300 trips per day; 45 cent fare) while the express service has been expanded as part of the demonstration project.

Phase 1A of the project, from April 29 to August 18, 1974, constituted a "pre-priority treatment" period during which Orange Streaker buses operated in mixed mode along I-95 from the Golden Glades Interchange to the four employment locations. Thirty specially designed 47-passenger buses equipped with bucket seats, carpeting, and air conditioning were purchased for the express bus service.

Phase 1 of the project, from August 19, 1974 to March 15, 1976, involved the transfer of express bus service to N.W. 7th Avenue and the implementation of various bus priority treatments. In this phase, emphasis was on evaluating the operational effectiveness and future applicability of techniques for providing priority bus treatment on an arterial street. The strategies tested, in order of implementation, were:

1. Traffic signal preemption.
2. Reversible reserved lane and signal preemption.
3. Reversible reserved lane and signal progression.
4. Reversible reserved lane and signal progression and preemption.

Reversible Reserved Bus Lane with Traffic Signal Preemption; N.W. 7th Avenue, Miami, Florida

Under the first strategy, the Orange Streaker buses operated in mixed mode along N.W. 7th Avenue. 3M OPTICOM equipment consisting of an emitter on top of the bus, a detector, and a signal phase selector enabled the bus to preempt traffic signals; that is, change the signal from red to green or hold the green phase until the bus passed through the intersection. The second strategy involved a combination of signal preemption and use of a reversible reserved lane in the middle of N.W. 7th Avenue for the entire length of the corridor. The third treatment consisted of centrally controlled signal progression (whereby the signals are set to change at prescribed intervals so as to favor express bus movement) and use of the reserved lane. The fourth strategy supplemented the third with bus preemptive capability.

A fifth scheme, which would have upgraded the fourth strategy by introducing central computer control geared to realign signal progression in the event it became out of phase with bus movement, was never initiated. Contributing to this change in plans were two factors: the time available to test later bus priority measures on 7th Avenue was compressed due to delays in implementing stage 3, coupled with on-time construction of the I-95 reserved lane; and an error in contract specification led to the construction of signal control software which was only slightly different from that which was thoroughly tested in stage 2.

Phase 2 of the project involves the operation of Orange Streaker buses along reserved lanes on I-95. Two additional median lanes (one in each direction of traffic flow) have been constructed for the use during peak periods of buses and carpools with three or more occupants. These lanes are not separated from the adjacent traffic lanes by any type of barrier or cone, but are delineated by special signing and pavement markings. An important objective of this phase of the demonstration project will be to measure the operational feasibility, ease of lane violation enforcement, and safety of non-separated reserved lanes.

Throughout the project, park-and-ride facilities are provided as a loading/staging area for bus patrons and carpoolers. A 900-space parking lot was constructed for use during Phases 1A and 1; a second parking lot with capacity for 1,300 vehicles and a ramp directly connecting the parking lot and reserved freeway lane are under construction for Phase 2.

Reserved Bus and Carpool Lane, I-95, Miami, Florida

Park-and-Ride Facilities for Bus Patrons and Carpoolers, Miami, Florida

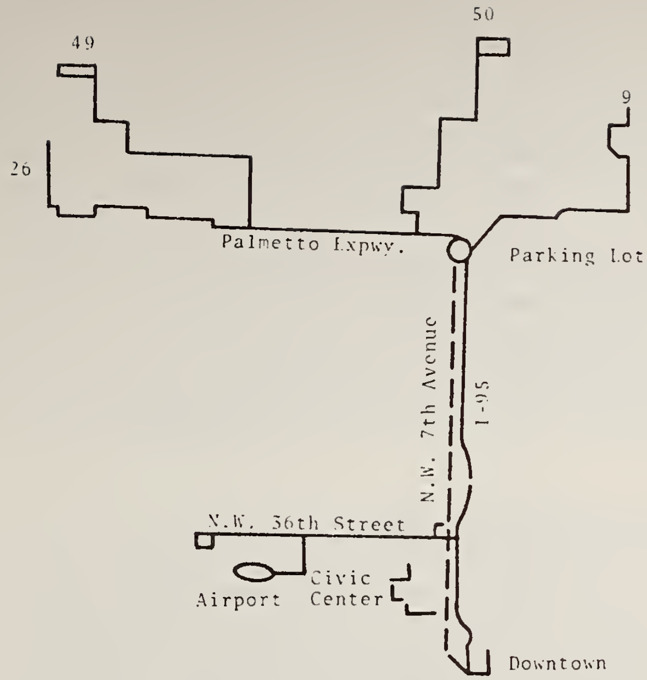
A significant feature of this project is its amenability to comparative evaluation. Since all phases essentially serve the same market area, it is possible to assess the incremental effects of major service changes of each type of preferential treatment on transit operations.

The Orange Streaker service implemented at the beginning of Phase 1A represents an expansion and rationalization of pre-existing express bus service in the corridor. Prior to this project, there were three express bus routes operated by the Metropolitan Dade County Transit Authority which provided service between residential communities in northern Dade and southern Broward Counties and two employment centers, downtown Miami and N.W. 36th Street. There were 18 daily trips (nine per peak period), six of which were retained after the introduction of Orange Streaker service. The fare was 50 cents per trip, regardless of whether the trip originated (terminated) in Dade or Broward County.

Figure A-3 shows the configuration and route length of the four express bus routes in the demonstration corridor. For the morning southbound service, some bus runs originate at the Golden Glades Parking Lot, while others perform local collection service (taking 20 to 30 minutes) before converging at the Lot to pick up park-and-ride, kiss-and-ride, and transfer passengers. The buses then travel south along N.W. 7th Avenue (Phase 1) or I-95 (Phase 2), destined for one of the four major employment centers shown in the figure. The fare is 60 cents for trips originating or terminating in Dade County and 75 cents for trips to or from Broward County. There is no charge for transfers or for parking at the Golden Glades facility.

Service is provided only during the peak periods, with bus departures from the Golden Glades Parking Lot between 6:00 a.m. and 8:25 a.m. and arriving there between 3:50 p.m. and 6:30 p.m. Under the original schedule 74 express trips were made per day, 37 in each peak period. This schedule was found to have too many duplicative and low patronage trips and therefore service was cut in September 1974 to 45 express trips per day. Since that time, operational adjustments involving rerouting, rescheduling, and adding trips, have been made. By the time Orange Streaker express bus service was transferred to Route I-95 in March 1976, 55 daily bus trips were being made.

Corridor transit coverage, as measured by the number of express bus trips, increased substantially after initiation of project service. Not only did the service represent a



Feeder Service to Parking Lot	Route Length (mi)
Route # 9	8.9
Route # 26	6.7
Route # 49	8.7
Route # 50	9.3

Express Service from Parking Lot to:	Route Length (mi.) N.W. 75th Ave.	I-95	Number of Daily Trips
Downtown	11.4	11.0	35
Civic Center	10.0	10.0	10
Airport	12.4	.2.2	2
N.W. 36th St.	11.5	11.3	8

FIGURE A-3. ORANGE STREAKER ROUTES, I-95/N.W. 7TH AVENUE, MIAMI, FLORIDA

net increase in the number of trips, but also an increase in the market area served: at the northern end of the corridor, Orange Streaker buses provide increased residential coverage to the northwest and northeast of the Golden Glades interchange; at the southern portion of the corridor, the buses serve two employment centers (Civic Center and Airport) formerly not served by express buses. The Golden Glades Parking Lot, by acting as a transfer point for the four feeder routes as well as a park-and-ride and kiss-and-ride facility, enables travel between any point in the residential market area and any employment destination, whereas the former express bus service only operated between selected origins and destinations, with no transfer capability. Furthermore, the four Orange Streaker feeder routes provide far more efficient and direct service in the residential area than the three express bus routes that they replaced.

PROJECT HISTORY AND STATUS

The Miami Bus/Carpool Project developed out of a study completed in January 1971 by Alan M. Voorhees and Associates for the Federal Highway Administration, entitled "Feasibility and Evaluation Study of Reserved Freeway Lanes for Buses and Carpools." This study, performed in the context of Cleveland's eight-lane I-90 Memorial Shoreway, concluded that the concept of reserving freeway lanes for buses and carpools was basically sound and worthy of demonstration. Following Cleveland's rejection of the demonstration proposal on grounds that enforcement of the reserved lane ordinance could not be achieved, the Federal Highway Administration solicited proposals for a demonstration. In July 1971 the Florida Department of Transportation responded with its proposal involving I-95. While grant negotiations were underway the proposal was expanded to include the N.W. 7th Avenue phase which would coincide with the I-95 construction period. The FHWA and UMTA grants were approved in the early part of 1973, and construction was initiated that summer. The demonstration project, which is scheduled to run approximately 4 years, began data collection and operational phases early in 1974.

CALENDAR OF EVENTS

01/01/74 Data collection activities for the "before" conditions (Phase I - stage 0) on N.W. 7th Avenue and I-95 began.

04/29/74 Orange Streaker express bus service is initiated between the Golden Glades park-and-ride lot and downtown employment locations operating in mixed mode with other traffic along Route I-95 (Phase 1A). Service consists of 74 one-way routes during the peak periods (6:00 a.m. to 9:00 a.m. and 3:30 p.m. to 7:00 p.m.) Monday through Friday. The first week of service is provided free, with no fares collected.

08/26/74 Orange Streaker express bus service is transferred from I-95 to the parallel arterial, N.W. 7th Avenue (Phase 1 - stage 1). Buses travel in mixed mode traffic, but are permitted to preempt traffic signals either to extend the length of a green signal or to shorten the time that a red signal is held at an intersection.

09/09/74 A major service reduction is implemented for the purpose of bringing service levels more in line with demand. Schedule cuts of approximately 39% result in the elimination of many duplicative and low patronage trips.

01/20/75 Orange Streaker bus service along 7th Avenue begins operation on a reserved center lane where the direction of bus traffic is reversed between the a.m. and p.m. peaks (Phase 1 - stage 2). Signal preemption is continued.

07/14/75 The first section of the I-95 priority lane is opened to the public. The Northbound lane is reserved for carpools on Monday through Friday from 3:00 p.m. to 7:00 p.m., while at other times it is open to all traffic.

12/02/75 The remaining sections of the I-95 carpool lanes are opened to the public. The added lanes are restricted to vehicles with three or more occupants on Monday through Friday from 6:00 a.m. to 10:00 a.m. and from 3:00 p.m. to 7:00 p.m.

12/12/75 The traffic control strategy on N.W. 7th Avenue is changed to preset directional progression on the reversible reserved lane (Phase 1 - stage 3). Preemption of traffic signals by buses is discontinued.

12/29/75 The operation of Orange Streaker bus service on N.W. 7th Avenue is switched, ahead of schedule, to

Phase 1 - stage 4, in which progressive timing of traffic signals is augmented by provision for bus activated signal preemption. The change in schedule is in response to poor performance of signal equipment used for progression, with the expectation that the combination strategy will be influenced to a lesser extent by maintenance problems than signal progression alone.

01/26/76 After several weeks of satisfactory traffic signal operation, the control strategy on N.W. 7th Avenue is returned to reserved lane and signal progression (Phase 1 - stage 3).

03/02/76 Transfer of express bus service to I-95 is delayed two weeks and the control strategy is again switched to reserved lane with progression and preemption (Phase 1 - stage 4) in order to gather data which was not collected in January.

03/15/76 Orange Streaker service is transferred to I-95 operating on the reserved bus/carpool lane from Golden Glades intersection to downtown Miami employment locations (Phase 2 - stage 5). A direct link (flyover) between the park-and-ride lot and the reserved lane is not yet in operation necessitating some mixed mode bus travel preceding entry into the parking lot.

04/24/76 A schedule readjustment, reflecting travel time savings, is instituted delaying express bus departure times for 5 minutes during the a.m. peak period at feeder locations and the Golden Glades lot.

12/76 Scheduled completion time for the flyover connecting I-95 and the Golden Glades park-and-ride lot (Phase 2 - stage 6).

FINDINGS

The demonstration program is currently operating in Phase II (on I-95), with Phase I (on N.W. 7th Avenue) completed in March 1976. The analysis of results will focus primarily on the alternative traffic priority schemes which were tested on N.W. 7th Avenue during the first phase of the program. Any results reported for Phase II are necessarily tentative and incomplete.

Travel Times

Since no actual express bus service was offered on N.W. 7th Avenue before the demonstration began, empty buses were operated along the route during stage 0 entirely for the purpose of measuring representative travel times. As seen in Table A-1, the average peak bus travel times decreased in stage 1 during which buses operated in mixed traffic with signal preemption by 5.1 minutes in the a.m. peak, and 7.9 minutes in the p.m. peak, 19% and 27% respectively. When buses were rerouted to a reversible reserved center lane in stage 2, travel time decreased by 2.7 minutes (10%) in the morning and 1.5 minutes (5%) in the afternoon. Average speed along the 9.9 mile N.W. 7th Avenue segment of the route exceeded 30 miles per hour during stage 2.

TABLE A-1

ORANGE STREAKER TRAVEL TIMES
N.W. 7TH AVENUE

		AM		PM	
	Stage	Travel Time (minutes)	Speed (mph)	Travel Time (minutes)	Speed (mph)
1-0	Express buses in mixed traffic	26.3	23	29.8	20
1-1	Traffic signal preemption	21.2	28	21.9	27
1-2	Reserved Lane and preemption	18.5	32	20.4	29
1-3	Reserved Lane and progression	*		*	
1-4	Reserved lane progression and preemption	*		*	

*Data not available.

The analysis of computerized data from stages 3 and 4 is still in progress, however, preliminary indications are that bus travel times did not change drastically during these stages. Bus travel time increased slightly when

progression replaced preemption in stage 3, and decreased by a small margin during stage 4 where preemption was reinstated in combination with progression. The evidence suggests that all bus priority schemes have sizeable positive travel time benefits in comparison with before-demonstration conditions, and that alternative traffic signal control meachanisms provide nearly the same level of improvement.

Orange Streaker express bus service was provided on Route I-95 both before and after service existed on N.W. 7th Avenue. During the period from April through August 1974, mixed mode express bus service to all downtown Miami destinations was routed on I-95. Although the trip distance on I-95 was slightly greater than on N.W. 7th Avenue, the travel times were roughly equivalent to those with signal preemption equipment on N.W. 7th Avenue. In March 1976, after the reserved lane on I-95 was opened, express bus service was again operated on I-95. Even though precise travel time data have not yet been compiled, evidence suggests that a travel time savings has been realized. In April 1976, bus schedules were updated for the morning peak moving departure times back 5 minutes for all runs. Statements from operating personnel indicate that this change was in response to travel time savings.

Variation in travel times is introduced when some buses are forced to make unnecessary stops at traffic signals or in congestion while others do not. The introduction of bus priority schemes, by reducing the number of stops, has led to reduced variation in travel time along N.W. 7th Avenue. As seen in Table A-2, the standard deviation of travel time decreased by approximately 50% from stage 0 to stage 4. These data were collected by instruments which automatically monitor and record bus speed, but which were in place only for stages 0, 3, and 4. Defining a late arrival as 2 or more minutes behind schedule, the proportion of buses which would be expected to arrive late given on-time starts can be derived. This measure decreases from 25% in stage 0 to 9% in stage 4.

TABLE A-2

BUS TRAVEL TIME VARIATION
N.W. 7TH AVENUE - PM PEAK

Stage		Mean[1] Travel Time	Standard Deviation	Percent ≥2 Minutes Late
1-0	Express buses in mixed traffic	29.4 min.	2.9	25%
1-1	Traffic signal preemption	*	*	*
1-2	Reserved Lane and preemption	*	*	*
1-3	Reserved Lane and progression	18.5 min.	1.8	13%
1-4	Reserved lane progression and preemption	18.4 min.	1.5	9%

[1]May not agree with other statistics due to measurement differences.
*Data not available.

In operation, the likelihood that a bus will be late is a function of both its travel time variability and the time it starts its route. Over the course of the demonstration schedule adherance has been measured at the Golden Glades park-and-ride lot. The proportion of buses which arrive late has ranged between 15% and 50% when averaged over any given month and does not appear to be correlated with stage treatment or seasonal variations. The reasons why improvements in travel time variation have not resulted in better on-time performance are under further investigation.

As indicated in Table A-3, auto travel times along N.W. 7th Avenue in the peak flow direction generally decreased as successive bus priority schemes were implemented. The travel time changes were attributable to traffic improvements which were intended to aid bus movement but which were beneficial to all traffic traveling in the peak direction. The separation of buses from other traffic, and the progression or preemption of traffic signals to regulate

the flow of buses have all contributed to more efficient auto operation along N.W. 7th Avenue. Auto travel time savings were not as great in magnitude as bus travel time gains and in one case, the transition from stage 3 to 4, auto travel times increased. In this case, the addition of bus preemption to other priority treatments seems to have disrupted the progression of traffic signals sufficiently to degrade the overall auto travel time on N.W. 7th Avenue. No conclusive results have been developed to date regarding auto travel times for traffic crossing N.W. 7th Avenue.

TABLE A-3

AUTO TRAVEL TIMES
N.W. 7TH AVENUE - PEAK FLOW DIRECTION

		AM		PM	
	Stage	Travel Time (minutes)	Speed (mph)	Travel Time (minutes)	Speed (mph)
1-0	Express buses in mixed traffic	27.3	22	29.9	20
1-1	Traffic signal preemption	25.0	24	25.7	23
1-2	Reserved lane and preemption	24.1	25	26.9	22
1-3	Reserved lane and progression	20.6	29	24.0	25
1-4	Reserved lane, progression and preemption	21.7	27	26.3	23

Ridership

As shown in Figure A-4, ridership on the Orange Streaker express bus service steadily increased from the conception of service in May 1974 until mid-1975. The number of average daily riders increased in this period from 1,150 to 1,700, a gain of approximately 60%. The significant service reduction and the transfer of service to N.W. 7th Avenue from I-95 in September 1974 had no noticeable ill effects on ridership during the early stages of the demonstration. After mid-1975, ridership leveled off

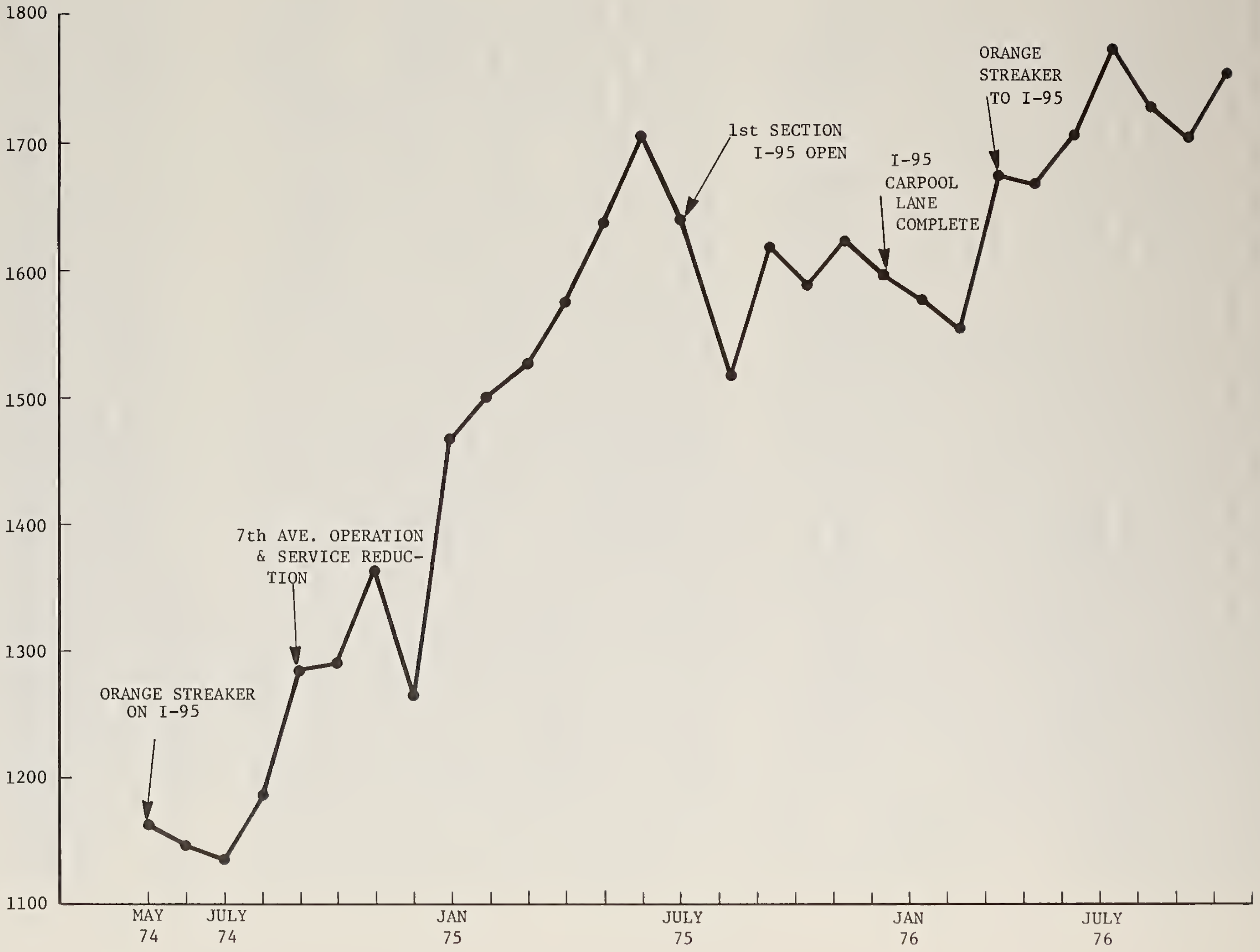


FIGURE A-4. AVERAGE DAILY RIDERSHIP

with monthly fluctuations representing seasonal factors. Increasing carpool formation on I-95 occurred at the same time as express bus ridership was leveling off, suggesting that carpoolers were drawing on potential bus riders. Average auto occupancy on I-95 after the reserved lanes were opened (stages 2, 3, and 4 of Phase I) was 12% higher than a comparable period before the reserved lanes were opened (Phase IA). In addition, the percent of vehicles consisting of 3 or more person carpools increased from 2.1% to 9.7% of a.m. traffic during the same period.

In March 1976, express bus service was moved from N.W. 7th Avenue to the I-95 reserved lane. With this service change, ridership increases resumed, culminating in the highest ridership level to date, 1,770 average daily users, reached in June 1976. Although the rise in usage coincided with the previous year's seasonal peak, it can be concluded that travel time and reliability improvements attributable to the transfer of service to I-95 were primarily responsible for renewed interest in the Orange Streaker service.

Access to Orange Streaker express buses is primarily gained through the Golden Glades park-and-ride lot. The present lot, offering 950 parking spaces, is scheduled to be replaced with a new lot with 1,300 spaces in December 1976. This new lot will facilitate travel time savings for buses and carpools by providing a direct connection to the I-95 reserved lane by use of a flyover (overpass). During N.W. 7th Avenue operation a special study was undertaken to determine the modes of access to the park-and-ride lot for a.m. peak passengers: 55% were park-and-ride, 25% arrived on feeder buses and 20% were kiss-and-ride. By the end of express bus operations on N.W. 7th Avenue, 450 vehicles per day were parking at the Golden Glades lot. The occupants of 415 vehicles used the park-and-ride mode, while the occupants of 35 formed carpools. Based on the high percentage of bus users whose trips originate from the park-and-ride lot, it is clear that this facility has been an important factor in attracting ridership.

Cost and Performance

The total committed project costs for the I-95/N.W. 7th Avenue demonstration are listed in Table A-4. The actual month-by-month operating costs for the Orange Streaker bus service are reported by the Metropolitan Transit Agency and include variable and fixed costs of express bus operations but do not include costs related to reserved lanes, traffic

signal priority equipment, or the park-and-ride lot. Bus costs have varied between $30,000 and $50,000 per month of operation with the minimum occuring in September 1974, after a severe service cutback was implemented and the maximum cost registered in April 1976. In the period after the service cut, the number of system vehicle hours averaged about 2,500 per month. Of these 45% have been revenue hours and 55% have been deadhead. The percentage of deadhead time for the Orange Streaker service is considerably higher than for the Miami bus system as a whole. With about 30 express buses in operation and 55 trips made for combined a.m. and p.m. peaks, buses generally make only one trip for each peak period.

TABLE A-4

PROJECT COSTS: I-95/N.W. 7TH AVENUE BUS/CARPOOL SYSTEMS DEMONSTRATICN PROJECT, MIAMI, FLORIDA

	PROJECT COSTS	
PLANNING AND IMPLEMENTATION:		$1,047,000
Evaluation	$802,000	
Marketing	$127,000	
Contingencies	$118,000	
CAPITAL COSTS:		$25,240,000
Construction		
2 new reserved lanes, parking and ramp	$22,450,000	
30 buses	$1,600,000	
Traffic Control	$950,000	
Signal Preemption	$240,000	
OPERATION COSTS:		
Operations 1974-1976		$600,000
Subsidy (operating deficit)		$211,000
TOTAL		$27,098,000

[1]Transportation planning had been done previously or was contributed and not charged to the project.

The cost per passenger trip, after running close to $2.00 when service was initiated, averaged between $0.90 and $1.20 for most of the N.W. 7th Avenue phase of the

demonstration. For the first few months of 1976, inflationary cost increases have pushed the cost per passenger trip up to as high as $1.40. The cost per vehicle hour has also increased from an average of about $13.50 per hour in 1975 to $17.00 per hour in January and February 1976. The average fare per passenger was about 60 cents per trip, which resulted in the Orange Streaker express bus system running at a deficit of between 30 cents and $1.40 per passenger trip.

The productivity of express bus service, as measured by the passengers per vehicle hour, has increased from under 6 during the first few months of operation in 1974 to a high of 15 in the second quarter of 1975. Since then, the number of passengers per vehicle hour of operation declined slightly before rebounding when service was transferred to I-95 in March 1976.

Accidents

During stage 2 of the demonstration a reserved center lane on N.W. 7th Avenue was added for use by express buses. This necessitated changing the configuration of other lanes, eliminating parking in some areas, and putting restrictions on left turning movements. This latter constraint, or rather the non-adherance of automobile traffic to it, has led to numerous accidents involving buses and autos. These accidents occurred when automobiles attempting left-hand turns across the bus lane collided with approaching buses. During Phase I of express bus operations, 65 accidents and 15 injuries were recorded on 7th Avenue involving express buses. The highest accident rates were registered during stage 2 after the reserved lane and turning restrictions were implemented. In this period, bus accidents occurred on the average of one every 4.5 days for a rate that was 5 times the national average for city buses. During stages 3 and 4 the accident rate was reduced as drivers became accustomed to the altered conditions on N.W. 7th Avenue, but accidents still occurred three times as often as before the reserved lane was introduced.

After Orange Streaker express bus service was transfered to I-95 in March 1976, the accident rate for buses declined. However, another type of accident related to the widening of I-95 surfaced as an even more serious problem. Construction of the reserved bus/carpool lane on I-95 eliminated the grassed median shoulders. These were replaced by a New Jersey barrier wall with 2-1/2 feet of separation between the wall and the reserved lane. This

left no refuge area for breakdowns, and the width of the highway (4 lanes) made it difficult for distressed motorists to move to the right shoulder. Numerous stops for fuel or repair have occurred in the reserved lane during offpeak hours when autos are permitted free use of the lane. These have led to over a dozen accidents directly attributable to this problem and four fatalities. In order to ameliorate the problem, lane marking and warning signals have been added to the highway. As yet it is too early to tell if these actions will be successful or if other measures must be taken.

Enforcement

Two distinct law enforcement problems have arisen in conjunction with the I-95/N.W. 7th Avenue bus priority project. As previously noted, a high percentage of bus accidents on 7th Avenue were caused by illegal left turning auto traffic. At intersections where a reserved center bus lane was implemented, a separate left turn lane was provided for other traffic. However, drivers also used the bus lane to make turns, thereby creating two parallel left turn movements for each approach, one being illegal. A study in late 1974 showed that 6.1% of left turns on N.W. 7th Avenue were illegal. By the end of June 1975 over 1,500 citations had been issued for left turn violations. Traffic violation records for the remainder of Phase I are not yet available.

A second major enforcement problem involves unauthorized use of the I-95 bus/carpool lane. During peak hours the added reserved lane is restricted to vehicles with occupancy of 3 or more. However, the level of police presence on I-95 has been hampered by manpower and funding shortages, and consequently, the violation rate in the reserved lane averaged as high as 60% of vehicles in that lane. In spite of this there has been little adverse effect on priority operations because the total use of the reserved lane is low.

User Characteristics

Surveys were held in the spring of 1975 for the purpose of defining express bus user and non-user socio-economic, travel, and attitudinal characteristics. These surveys are scheduled to be updated in the fall of 1976. The significant conclusions drawn from the 1975 surveys are the following:

- Prior to the implementation of Orange Streaker bus service, 52% of the express bus riders were in single occupant vehicles, 15% were in carpools, and 18% indicated that they used the existing express or local bus service in the corridor. Fourteen percent of the people riding the system did not make the trip prior to implementation of the project.

- The express bus service attracts users who have lower household income and are more likely to be females.

- While the express bus service attracts riders who are less likely to have drivers licenses and who own fewer automobiles than non-users, 85% of the users have automobiles available for their trips and can be termed choice riders.

- A commuter with a destination in downtown Miami, where parking is expensive and express bus service is frequent, is much more likely to use the Orange Streaker service than is a commuter with a destination in the N.W. 36th Street employment area, Miami International Airport, or Coral Gables, where parking is less expensive and express bus service is less frequent.

- The most often expressed discontents of express bus users were that there was insufficient frequency of service and high fares. The factors that most strongly influenced non-users in deciding to continue with their present mode of travel was the inconvenience of bus routes and schedules.

Implications

The Orange Streaker express bus demonstration project in Miami, Florida, has been underway since the winter of 1973/74, and is scheduled to continue until the summer of 1977. An interim report analyzing the alternative bus priority schemes which were implemented on the major arterial, N.W. 7th Avenue, is due to be released in the fall of 1976, while the final report, incorporating an analysis of reserved lane operation on the parallel freeway, I-95, will await the completion of the demonstration period. In the absence of these analyses the discussion of any finding must be preliminary and incomplete, but some trends, which deserve amplification, appear to be emerging.

The public reaction to most aspects of the corridor improvement project has been positive. Neither the demonstrations nor lawsuits against the project, which have been experienced in other locations where transit priority systems were initiated, have been in evidence in Miami. One reason for this success is that both traffic signal priority on the major arterial and the added reserved bus/carpool lanes on the freeway helped to improve auto travel times as well as bus travel times. Thus the transportation improvement project was seen as a benefit to users and non-users of the express bus system alike.

Only in the accident record and traffic violation frequency has the demonstration project fared badly against previous experience and in the public's eye. For both N.W. 7th Avenue and I-95, the physical design characteristics of the reserved lanes has resulted in a elevated incidence of accidents. On the arterial, left turn movements were made more difficult and confusing, while on the freeway the elimination of the breakdown lane has caused disabled vehicles to be left dangerously in the path of oncoming traffic. Better lane markings and stricter police enforcement are possible solutions to these problems. However, the experience in Miami leaves no doubt that safety should be carefully considered in the early planning of all transportation improvement programs.

The impact on express bus travel times of preferential bus treatment on the N.W. 7th Avenue was uniformly positive. Each scheme by itself is unquestionably beneficial, however, there seems to be little bus travel time difference between signal progression and signal preemption when used in conjunction with a reserved lane. Signal progression was slightly more advantageous to auto traffic on the arterial. Since signal progression is the simpler and cheaper of the schemes to implement, the results in Miami tend to support its application at future sites.

APPENDIX B

SANTA MONICA FREEWAY PREFERENTIAL LANE PROJECT

OVERVIEW

On March 15, 1976, the median lane in each direction of a twelve-mile, eight-lane segment of the Santa Monica Freeway in Los Agneles was reserved for the exclusive use of buses and high-occupancy vehicles carrying three or more occupants. The preferential lanes operated in each direction during the peak hours of traffic flow. No barriers separate the preferential lanes from the remaining lanes of freeway traffic. The designation of the preferential lanes was accompanied by the introduction of a variety of express bus services and the opening of three new Park-and-Ride lots in Western Los Angeles. The lanes operated amid much controversy for twenty-one weeks, until August 9, 1976, when Judge Matthew Byrne of the U.S. District Court in Los Angeles halted the project and ordered additional environmental studies prior to its continuation.

The Santa Monica Freeway, which connects the City of Santa Monica and downtown Los Angeles, is one of the most heavily traveled freeways in the world, carrying approximately 240,000 vehicles per day. The freeway is flanked by a broad band of arterial streets offering alternative routing possibilities, and is served by a variety of sophisticated traffic control devices. These include metered on-ramps with preferential entry provisions at selected locations for vehicles with two or more occupants, a computerized surveillance system, and centrally-controlled electronic displays.

The Preferential Lane Project, known locally as the Diamond Lane Project, was jointly sponsored by the California Department of Transportation (CALTRANS), the Southern California Rapid Transit District (SCRTD), the Santa Monica Municipal Bus Lines (SMMBL), and the California Highway Patrol (CHP) in an effort to improve air quality, reduce energy consumption, and increase effective freeway capacity by increasing the occupancy of buses and automobiles using the freeway. Other local agencies that participated in the project included the Los Angeles Police Department (LAPD), the Los Angeles Department of Traffic (LADT), the Office of the Mayor of Los Angeles, and Commuter Computer (a local non-profit organization providing carpool matching service).

Since the dedication of an existing freeway lane to high-occupany traffic was a controversial measure with impacts that are at present incompletely understood, it was essential that the full range of these impacts be measured and evaluated with a high degree of statistical precision in order to ensure the greatest possible level of understanding, not only in the area served by the Santa Monica Freeway, but in all areas interested in implementing similar preferential freeway lanes. To this end, the Urban Mass Transportation Administration (UMTA) sponsored a detailed evaluation of the impacts of the Diamond Lane Project as part of its Service and Methods Demonstration (SMD) Program.

Funding and Sources

For the first year of the Santa Monica Freeway Preferential Lane Demonstration Project, the total cost was estimated to be $3,250,500. This total was composed of approximately $100,000 for capital expenditures on the freeway system and $3,650,500 for operating expenses incurred by all participating agencies.

A total of $1,189,000 in direct Federal participation by two federal government agencies, UMTA and FHWA, was involved in the project. UMTA grant CA-06-0083 was for $807,800 to the SCRTD while UMTA grant CA-06-0086 was an inter-agency transfer to FHWA for $100,000 to be added to $127,000 in survey funds already committed by that agency. UMTA, through TSC, has committed $154,000 for project evaluation. These federal funds were allocated to the following five categories of operating expenses:

	UMTA		FHWA
	Via TSC	Direct	
1. Project evaluation	$154,000		
2. Data collection and review		$335,000	$127,000
3. Marketing and public information		368,000	
4. Local agency administration		131,000	
5. Contingency fund (administered by the Joint Project Board)		74,000	
Totals	$154,000	$908,000	$127,000

OBJECTIVES AND EVALUATION ISSUES

One of the primary goals of the Santa Monica Freeway Preferential Lane Project was to improve the effective people-moving capacity of the freeway. The participating agencies established the following specific local objectives:

- To explore and evaluate concepts aimed at increasing vehicle occupancy on heavily-traveled urban freeways by creating incentives to encourage public transit ridership and carpooling;

- To improve air quality in the Los Angeles South Coast Air Basin by reducing the number of low-occupancy vehicular trips;

- To contribute to the local and national goals of energy conservation by making passenger trips more efficient through public transit ridership and carpooling;

- To reduce existing peak hour congestion delays on the Santa Monica Freeway by increasing the ratio of travelers to vehicles using the freeway;

- To improve transit reliability and reduce transit travel times by providing an exclusive lane for bus and carpool travel;

- To achieve a better understanding of public attitudes toward automobile use, carpooling, transit ridership and preferential lanes, and to trace the effect of these attitudes on mode choice behavior; and

- To assess the benefits and costs of a variety of alternative concepts aimed at providing preferential freeway treatment for high-occupancy vehicles and acquire a better understanding of the law enforcement and traffic safety implications of each concept.

These local objectives met the following broad objectives of the Service and Methods Demonstration (SMD) Program:

To reduce trip times for transit travelers;

To increase transit reliability; and

To improve transit vehicle productivity.

Key Issues to be Evaluated

The Santa Monica Freeway Project marked the first time a preferential lane project had been initiated by taking a freeway lane out of existing service and dedicating it to the exclusive use of high-occupancy vehicles. As such, the project was implemented with significantly lower levels of capital investment and set-up time than such other preferential treatment concepts as described below. The project was one of four preferential treatment concepts initially scheduled for testing and evaluation in the Los Angeles area. The other three concepts entailed:

1. Construction of separate roadbeds for the exclusive use of buses and carpools:

2. Widening of existing roadways to provide an additional concurrent-flow lane for the exclusive use of buses and carpools; and

3. Creation of reserved-entry lanes for buses and carpools at metered on-ramps.

Thus, one of the aims of the project evaluation was to provide a solid foundation for comparing the Santa Monica Project with these other preferential treatment concepts. The Santa Monica Freeway itself offers more than one type of preferential treatment to buses and high-occupancy vehicles. At twelve of the metered on-ramps providing access to the Santa Monica Freeway, preferential bypass lanes provide immediate access for buses and vehicles carrying two or more occupants. To the extent possible, the evaluation plan attempts to isolate the relative contributions of the metered entry ramps, the preferential bypass lanes, and the Diamond Lane to the measured impacts of the total project.

Since no barriers separate the Diamond Lane on the Santa Monica Freeway from lanes serving non-carpoolers, who enjoyed the use of the lane prior to project implementation, the issues of safety, enforcement, and public response have been key concerns in the evaluation. Other important issues relate to project objectives and address questions concerning vehicle occupancy, air quality, energy consumption, transit ridership, congestion, travel speeds on

both the freeway and surface streets, transit reliability, travel times, and vehicle productivity.

PROJECT DESCRIPTION

Diamond Lane

The median lane in both directions of a segment of the Santa Monica Freeway was reserved for the exclusive use of buses and vehicles carrying three or more persons. An overview of the project, as originally conceived, appears in Figure B-1. The preferential freeway lanes, called the Diamond Lanes, were marked with large painted diamonds and directional signs strategically placed along the freeway. This 12.6 mile segment of the freeway running east and west is bounded by Lincoln Boulevard in Santa Monica and the Harbor Freeway in Los Angeles. No special stickers or permits were required to use the Diamond Lanes. There were no barriers partitioning the lanes, so buses and carpools are free to enter or leave the lanes anywhere along the route. The preferential lane rules applied between 6:30 a.m. and 9:30 a.m. and between 3:00 p.m. and 7:00 p.m. Monday through Friday. The Diamond Lane rules were enforced by the California Highway Patrol (CHP) officers. The wide median shoulder area provided adequate space to issue citations, so that violators did not have to be escorted through heavy traffic in the other lanes.

Transit Service

SCRTD and SMMBL expanded their service for the project by adding a total of seven new routes and 52 additional buses. In addition, four SCRTD express bus routes in operation on the freeway prior to project implementation were able to take advantage of the preferential lane. Buses on these routes provided peak period service to and from downtown Los Angeles on the Santa Monica Freeway at 10- to 15-minute headways (on each route). Prior to September 1975, neither transit company had routes using the Santa Monica Freeway. Because the Diamond Lanes were originally scheduled to open on September 15, 1975, SCRTD began operating four of their routes on the freeway in September 1975. SCRTD buses began operating on the remaining six freeway routes on March 15 at the same time as the actual opening of the Diamond Lanes. SMMBL, a smaller company, also began operating seven buses on one route between the City of Santa Monica and downtown Los Angeles on March 15, and added four buses to this route on April 15, 1976. SCRTD

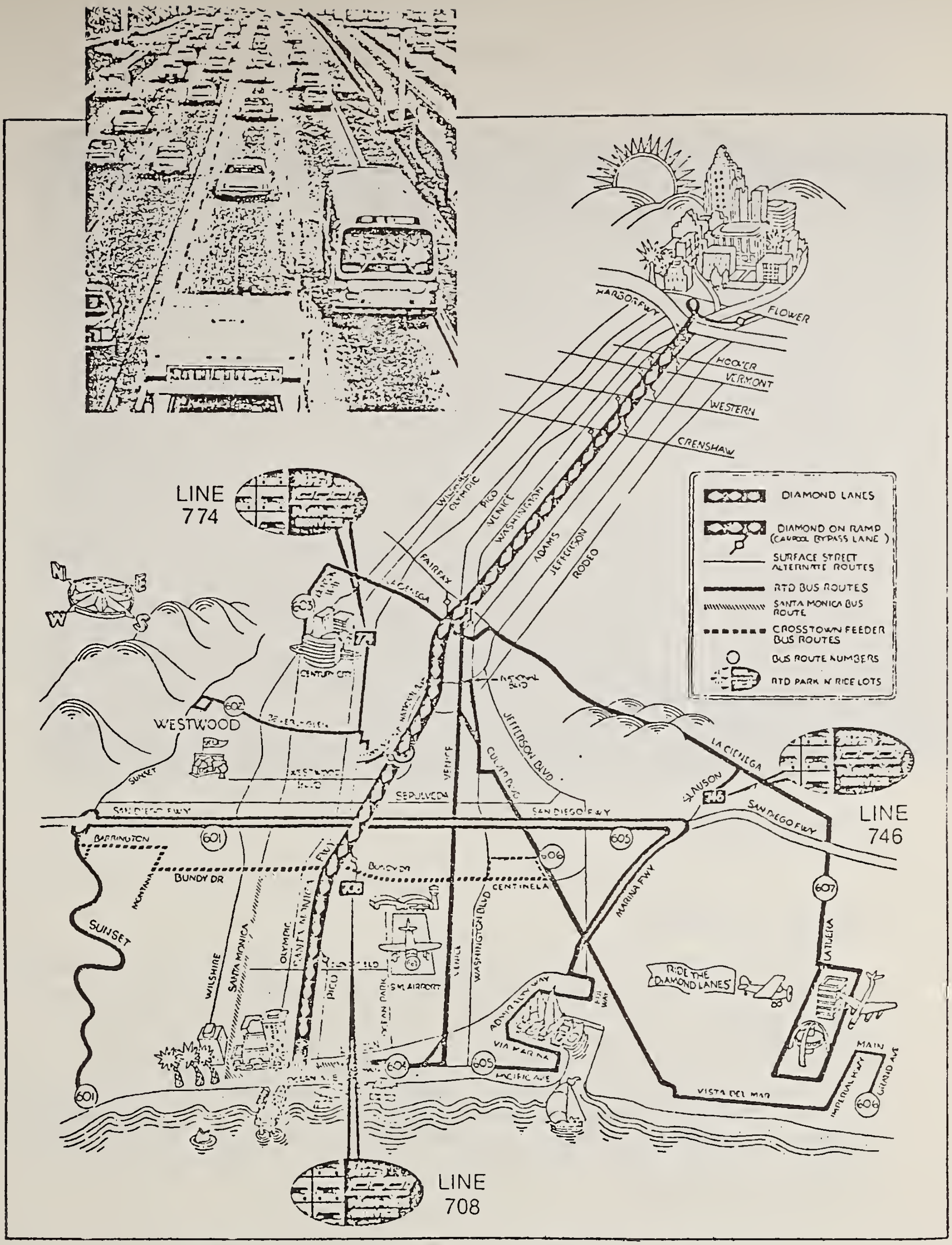


FIGURE B-1. OVERVIEW OF THE SANTA MONICA DIAMOND LANE PROJECT

also opened three new Park-and-Ride lots at the following locations:

	Auto Capacity
1. Fox Hills (south of Slauson at Marina Freeway)	200
2. Century City (southeast corner of Olympic Boulevard and Avenue of the Stars)	300
3. Southeast Santa Monica (corner of Centinela and Ocean Park Boulevards)	220

Express buses ran from these paved, fenced, lighted, and attended lots into downtown Los Angeles. For a monthly fee of $18 or $27 depending on the location of the lot, Westside commuters could park in a secured lot and board an express bus for the non-stop trip into Los Angeles on a preferential lane. The monthly fee included the bus fare and parking cost. For those who elected not to purchase a monthly pass, there were special one-way fares of $.50 or $.75 for parking and transportation.

Following the court injunction opening the Diamond Lanes to all vehicles, the operation of all park-and-ride lots was discontinued. However, most of the other bus routes introduced at the time of project initiation remain in operation.

Metered On-Ramps

The volume of traffic entering the freeway via on-ramps is controlled by metering signals to maintain free flow on the freeway. Metering rates, which are pre-set manually, were adjusted to compensate for the increased freeway congestion accompanying the Preferential Lane Project. Buses and carpools are privileged to bypass the ramp meters at selected on-ramps as an added incentive to these modes of travel. Vehicles carrying two or more persons were allowed to use the preferential bypass lanes on these selected freeway on-ramps.

Autos Waiting at Metered On-ramp with Bypass Lane for Buses and Carpools, Santa Monica Freeway, California

Diamond Lane in Operation Showing Electronic
Sign and Autos Waiting at Metered On-Ramp,
Santa Monica, California

Computerized Surveillance and Electronic Signs

As part of the 42-mile surveillance loop established by CALTRANS, detectors on the freeway transmit signals to a computer located in downtown Los Angeles. This electronic surveillance system provides instantaneous information on the freeway traffic, permitting the rapid detection of congestion due to accidents or other incidents. This computer also displayed information about traffic conditions and Diamond Lane use on electronic signs strategically placed along the freeway.

Marketing

In cooperation with the Los Angeles Mayor's Office, a telephone information center was set up to provide Los Angeles residents with information on bus schedules, carpooling, alternate routes, and preferential lane use. This call-in center also provided a medium for the expression of public opinion concerning the project. The telephone answering service was started fifteen days before the project began, and was maintained for three weeks after implementation. (Calls to this number were later referred to CALTRANS.) The forty telephone lines were answered by volunteers and personnel from CALTRANS, SCRTD, SYSTAN, Commuter Computer and the Mayor's Office.

Carpool information and transit usage were encouraged by a marketing campaign conducted by a subcommittee of the SCRTD-CALTRANS Joint Project Committee. This effort included newspaper advertisements, radio and television broadcasts, and the distribution of brochures designed to inform the public about the project. An estimated total of $368,000 of UMTA's funds were allocated to this marketing campaign, with $100,000 going to CALTRANS for automobile user information and $268,000 to SCRTD and SMMBL for transit user advertising.

In response to adverse public reaction following the inception of the Diamond Lanes, an ad hoc marketing campaign was initiated by CALTRANS and SCRTD, directed at workers in the downtown Los Angeles area. Personnel from these agencies visited businesses and offices in the CBD, disseminating information on carpool formation and transit usage.

Carpool Information

Free assistance in forming carpools is offered by Commuter Computer, a local non-profit organization supported by the City and County of Los Angeles. People filing a carpool application from with Commuter Computer receive a list of carpool candidates who live and work near them and have compatible schedules; they may then call these candidates and form a carpool on their own. After filling out the application, it generally takes one month to form a carpool.

Site Characteristics

The Preferential Lane Project was conducted in West Central Los Angeles County, a fully-developed urban area in Southern California. Figure B-2 shows a map of the area affected by the project, with a dark line around the area of primary impact. The Santa Monica Freeway, running from west to east, connects the City of Santa Monica to downtown Los Angeles. The preferential lane was established on a 12.9 mile segment of the freeway between Lincoln Boulevard (California Highway #1) in Santa Monica and the Harbor Freeway in Los Angeles.

HISTORY AND STATUS

Calendar of Events

November 1973	The Federal Environmental Protection Agency(EPA) was granted a mandate to impose a transportation control plan on the South Coast Air Quality Control region which would have imposed severe restrictions on auto usage in an effort to reduce vehicle miles of travel (VMT). The primary aim of the VMT reduction effort is to achieve ambient air quality conforming to the standards established by the Federal Clean Air Act of 1970. This VMT reduction was also intended to reduce energy consumption and congestion.
April 1974	The Southern California Association of Governments (SCAG) responded by adopting a short-range transportation plan for the region, including a program of

FIGURE B-2. PROJECT AREA

	preferential treatment for high-occupancy vehicles. CALTRANS assumed the responsibility for testing different preferential treatment concepts on freeways and implementing the most effective of these concepts throughout the region. The Santa Monica Freeway Preferential Lane Project was one of the first projects to be tested because it involved no major physical modifications and construction costs were very low compared to other concepts.
April 16, 1975	UMTA and FHWA made available $1,189,000 in Federal funds for a one-year trial Preferential Lane Project on the Santa Monica Freeway with an initial implementation date of June 15, 1975.
May 1975	The project implementation date was rescheduled to September 29, 1975 as a result of a variety of concerns including operational readiness and funding availability.
August 1975	A pre-implementation, FHWA-sponsored home interview survey was conducted. Problems in filling out the desired sample categories caused the interview process to extend through March 1976.
September 1975	Santa Monica City Council officially voted to support the project, ensuring the participation of the Santa Monica Municipal Bus Lines (SMMBL).
October 1975	The Joint Project Board officially rescheduled the implementation date for March 15, 1976 in response to the request of the SCRTD Board of Directors because of difficulties over Item 13c of the UMTA Act. This date was set to avoid the Christmas holidays, evening darkness, and the winter rainy season, which would make motorcycle enforcement of the preferential lanes difficult.
December 1975	Governor Brown of California signed Assembly Bill 918 into law to become effective January 1, 1976. Although the

primary purpose of the bill was to permit vanpooling, it specifically encouraged CALTRANS to establish, as soon as possible, preferential lanes for the use of buses and three-passenger carpools as a pilot project.

January 1976	SCRTD's Board of Directors received a ruling that resolved the dispute over federal labor restrictions imposed by Section 13c of the National Mass Transportation Act of 1974.
January 1976	CALTRANS reached an agreement with the Los Angeles Department of Traffic (LADT) concerning the left-turn restrictions at on-ramp entrances and the hours of preferential lane operation. LADT had argued to limit the preferential lane operation to peak hours and to the peak direction, as opposed to the planned 24-hour operation in both directions. A compromise calling for 13-hour (6 a.m. to 7 p.m.) operation in both directions was agreed upon by all participants.
February 6, 1976	The Joint Project Board revised the hours of Preferential Lane operation in response to objections raised by members of the Los Angeles City Council. The operating hours were set at 6-10 a.m. and 3-7 p.m. in both directions.
March 2, 1976	The project implementation date of March 15, 1976 was formally verified and publicly announced.
March 15, 1976	The Diamond Lanes opened as scheduled. The first day of operation was disastrous, featuring extreme congestion and delays, meter malfunctions, and an excessive number of accidents, all of which were characterized by the local press as chaotic. SCRTD began seven new express bus routes, three of which served new Park-and-Ride lots. SMMBL began one new route. A total of 70 buses were committted to these routes by the two transit companies.

March 29, 1976	A controversial barricade was removed and replaced by a metered signal on the transition roadway between the Harbor and Santa Monica Freeways near downtown Los Angeles.
March 29, 1976	A civil suit to stop the State from operating the preferential lanes was filed against CALTRANS by Eric Julber, an attorney living in Santa Monica. He sought a Superior Court injunction claiming that the State had failed to file an Environmental Impact Statement for the project and that the project violated the 5th, 9th and 14th Amendments to the Constitution of the United States.
March 31, 1976	The U.S. Secretary of Transportation, William T. Coleman, visited Los Angeles and publicly urged that the project be given a chance to work and be viewed in a broader perspective.
April 5, 1976	Adriana Gianturco, Director of CALTRANS, called a meeting in Los Angeles and stated that the future of the project is being left open. She decided to retain the "trial project" for six to eight weeks, after which CALTRANS would "take another hard look at it." Governor Brown endorsed her decision, stating that much more time is needed to adequately evaluate the experiment.
April 8, 1976	City Traffic Engineer S.S. Taylor ordered that all on-ramp left-turning restrictions be removed from city streets.
April 9, 1976	A second lawsuit against the Preferential Lane Project was filed by the Pacific Legal Foundation (PLF), a Sacramento-based public interest law firm. PLF filed the suit in the U.S. District Court, claiming that the sponsors had failed to prepare Environmental Impact Statements before implementing the project, and that "the public would suffer substantial and

	irreparable injury unless the project is terminated immediately."
April 15, 1976	U.S. District Court Judge Matthew Byrne, Jr., citing "serious legal and factual issues," ordered a trial to decide whether the Preferential Lane Project should be stopped in response to the PLF suit. The trial date was set for May 4, and the Judge refused to issue a preliminary injunction to stop the project during the interim period.
	SMMBL added four buses to service their Diamond Lane route.
April 19, 1976	A marketing campaign was initiated in the downtown Los Angeles area by CALTRANS and SCRTD in an effort to inform workers in the CBD about the use of buses and the formation of carpools.
April 26, 1976	Vanpool Program begins.
May 6, 1976	Adriana Gianturco, Director of CALTRANS, held a press conference to announce a change in the morning hours of Diamond Lane operation. Under the new schedule, implemented on May 17, the lane will open at 6:30 a.m., with restrictions being removed at 9:30 a.m. She expressed general optimism over continued improvement in lane performance and its effect of increasing carpool use and bus ridership, and left the press and the public with the message, "Give it time."
May 10, 1976	Service to the Century City Park-and-Ride lot was discontinued for want of sufficient ridership. This freed five buses which SCRTD does not plan to redeploy on project routes.
May 17, 1976	The announced change in project operating hours goes into effect.
May 20, 1976	A group of citizens in favor of the Diamond Lanes was formed to promote the use of the Diamond Lanes.

June 1, 1976	The California Highway Patrol reduced the level of enforcement assigned to the project area; 50% of the original increase in officers were reassigned to other areas.
June 15, 1976	CALTRANS officials opened the first of sixty planned Park-'N-Pool lots, where carpoolers may meet before riding to work together. The first lot was donated by the California National Guard and is located just south of Wilshire Boulevard in West Los Angeles.
June 15, 1976	Los Angeles City Councilman Marvin Braude called a press conference to announce the first public hearing on the Diamond Lane Project, which was held on June 21st. The Councilman warned that if CALTRANS could not produce "concrete reasons" to support the Diamond Lanes, he would take action to end them.
June 15, 1976	Adriana Gianturco, Director of CALTRANS, attended the Los Angeles County Board of Supervisors meeting. She argured for the continuation of the controversial project, describing it as the Los Angeles area's "most sensible, flexible" transportation alternative. A majority of the Supervisors agreed with her, defeating a motion by Supervisor Kenneth Hahn to request that Governor Brown halt the Diamond Lane project immediately.
June 21, 1976	Approximately 250 people attended the first public hearing on the Diamond Lane project. The hearing began with panelists presenting their arguments for and against the project, and were followed by citizens expressing their opinions.
June 22, 1976	The Automobile Club of Southern California urged the state to abandon the Diamond Lane experiment.
June 28, 1976	The City Traffic Engineer held a press conference announcing that the Diamond Lanes have increased traffic volunes

13.1% on city streets in the corridor, causing a 26% reduction in overall travel times, and that the number of accidents has increased from 1975.

June 28, 1976	Meeting in a special session, SCRTD directors authorized fare increases in response to a reduced revenue-subsidy from the County Board of Supervisors. The basic fare was raised by $.10 to $.35 effective July 1st. In addition, the Transit District imposed a $.10 surcharge for patrons riding buses on the Santa Monica and San Bernardino Freeways preferential lanes. Also under the new system, park-and-ride patrons (who have been paying $.50 on RTD buses) will now be charged $.65, and the new rate will be $1.00 for those who previously paid $.75.
June 30, 1976	SCRTD conducted an on-board survey of riders on its project lines during both the morning and evening hours.
June 30, 1976	The U.S. District Court trial to decide whether or not the Diamond Lane Project should be stopped commenced with Judge Matthew Byrne presiding.
July 22, 1976	State Secretary of Business and Transportation, Donald Burns, reported that the San Diego Freeway Diamond Lane project, tentatively scheduled to open in September, will be delayed.
August 4, 1976	The State Assembly Transportation Committee voted 7 to 7 on Assembly Bill 4525 which would repeal CALTRANS' authority to run the Santa Monica Freeway Diamond Lane Experiment.
August 9, 1976	Judge Byrne ruled that an Environmental Impact Report (EIR) must be filed under both national and state environmental laws. The Freeway Diamond Lanes were to be returned to pre-project status by August 13. CALTRANS has 180 days from this date to file the required EIR.

August 13, 1976 Official project termination date.

Current Status

On Monday, August 9, U.S. District Court Judge Matthew Byrne ruled that CALTRANS had failed to study the environmental impacts of the Diamond Lane Project as required by Federal and State environmental laws. Judge Byrne ordered that the Santa Monica Freeway be restored to its "pre-project status" by Friday, August 13, and gave CALTRANS 180 days from this date to file the required environmental impact report (EIR). This ruling was made in response to the suit filed by Pacific Legal Foundation (PLF), a Sacramento-based public interest law firm. Judge Byrne also announced that he would retain jurisdiction over the Freeway until CALTRANS completes the environmental study.

In the wake of the court decision on Monday, enforcement of the Diamond Lane restriction was aborted by the California Highway Patrol (CHP) on Tuesday morning, August 10. The public announcement of this decision by the CHP essentially terminated the project, as hundreds of single-occupant motorists poured into the Diamond Lanes on Tuesday, even though the Diamond Lane rules were offficially in effect until Friday, August 13.

Theoretically, CALTRANS could reinstate the project by filing an environmental impact report and obtaining court approval. However, the Judge's decision left CALTRANS uncertain whether or not they will file an appeal. It is also not clear whether or not they will file the EIR because of the strong public reaction against the project. Furthermore, the similar Diamond Lane Project that is planned for the San Diego Freeway in September will be postponed indefinitely.

At this point, it does not appear that the injunction against the Diamond Lanes will affect bus schedules in the near future. Both participating transit agencies (SCRTD and SMMBL) plan to continue their current Santa Monica Freeway service indefinitely. SMMBL had recently raised the fare on its freeway route from \$.50 to \$.80, and plans to leave the fare at this level. SCRTD has also increased fares throughout the region and, in addition, imposed a \$.10 surcharge for its Diamond Lane service. However, now the District will eliminate this surcharge so that fares will be \$.35 for short trips and \$.70 for longer interzonal trips. A labor strike and budgeting problems may force additional

cutbacks in the level of transit service provided by SCRTD. SCRTD will be monitoring ridership levels following the strike to decide what changes, if any, should be made in their service.

Some preliminary findings regarding bus and carpool ridership trends over the duration of the project are presented in the next section.

FINDINGS

After several implementation delays, the median lane in both directions of the Santa Monica Freeway was reserved for the exclusive use of buses and carpools on Monday, March 15, 1976. The project was terminated on August 13, 1976, after 22 weeks of operation. As a result of this abrupt termination, it is unlikely that conclusive evidence will be amassed on air quality data, or that the reasons underlying the increased accident rates shall ever be known or fully understood. Also lost was the ability to explore new avenues of investigation suggested by the initial results of the data analysis. Nevertheless, it appears that a sufficient amount of data has been collected to document exactly what happened during the five months the project was in operation. A comprehensive analysis of the impacts and problems of the Diamond Lanes is currently in progress, but the results are not available at this time. The public controversy surrounding the project required the intensification of data collection and analysis efforts. At this stage, some preliminary findings regarding bus and carpool ridership have been observed. These trends and other significant performance measures are summarized below.

Freeway Performance

The opening day performance was disastrous, with congestion compounded by several abnormal incidents, including a "spilled load," a multiple rear-end accident, and a ramp meter malfunction (stuck on green). This congestion led to an excessive number of accidents and was attributed to the project by the public, thus causing adverse public reaction.

Performance improved dramatically on the second day of operation, and the flow on the freeway continued to improve slowly through the end of the project as more people shifted to buses and formed carpools.

Travel Times

Although freeway travel times for non-carpoolers improved throughout the project, travel times never reached pre-project levels. Automobiles traveling over the 12.5 mile length of the project in the non-preferential lanes averaged 20 minutes for the inbound morning trip and 22 minutes for the outbound trip during the evening peak. Comparable travel times prior to the project were 16 minutes and 18 minutes, respectively. At certain on-ramps, moreover, waiting times increased during the project, adding to total trip delays experienced by non-carpoolers.

As indicated in the table below, before and after comparisons of delays in the on-ramp queues revealed much variation. In general, average delays experienced in the morning by eastbound traffic decreased slightly at the three busiest on-ramps, while average delays experienced in the evening by westbound traffic increased and the range of maximum delays increased as well.

AVERAGE AND MAXIMUM ON-RAMP DELAYS (MINUTES)

(Measured at the Five Busiest Locations)

	EASTBOUND A.M.						WESTBOUND P.M.			
Ramp	Overland		Manning		Lincoln		Hoover		LaCienega	
Time	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.
Before Diamond Lane	9.5	5	10	6	5	3	6	3.5	6	4.5
First Week	13	8	21	16	6	3	9.5	8	9	4.5
Fifteenth Week	6.3*	3.5*	11.8*	5*	4.8	1.5	12	7	14	6.5
Twentieth Week	6.8*	3.8*	10.8*	5*	7.3	2.3	10.8	6.5	14.8	7.5

*Data indicated reflect use of traffic-sensitive meters which allowed freer access during periods of uncongested flow, thereby lowering the average ramp delay.

Total Users - Vehicles, Persons, and Occupancy Rate

Prior to the start of the Diamond Lanes, the Santa Monica Freeway on the average day carried 96,950 vehicles on all lanes combined in the 7-hour period from 6:30 to 9:30 a.m. and from 3:00 to 7:00 p.m. During the first week of operation this number dropped by 21% to 76,175 vehicles. Almost 30% of this drop was regained by the end of the third week. By the end of the 15th week there were 84,350

vehicles using the freeway during the 7-hour peak periods. This was 13% fewer than prior to the project. By the end of the project's operation (21st week), the number of vehicles had risen to 89,750, 7% fewer than the preproject.

The total number of travelers, or persons in all vehicles, including buses, on all lanes of the freeway, in both directions (7-hour peak period) numbered 118,750 prior to initiation of the Diamond Lane. This dropped to 98,330 in the first week, or 17% fewer. By the 3rd week this had increased to 108,600. While varying somewhat erratically thereafter, the number of persons rose to 113,450 by the end of the 15th week. This was over 95% of the preproject figure (113,450/118,750). During the final three weeks of project operation, the number of persons on all freeway lanes increased steadily to 122,225 at the end of the 21st week. This is 2.9% more persons than preproject. Thus, the freeway was carrying about 3% more persons in 7% fewer vehicles.

Reflecting the relationship between change in the number of vehicles and change in the number of persons using the freeway is change in the vehicle occupancy rate. Prior to the project, each vehicle carried an average of 1.23 persons in the rush period. Occupancy increased to 1.29 in the first week of the project's operation, had gone up to 1.31 by the 9th week, and in the 15th week was 1.34. By the end of the 21st week the occupancy rate was 1.36 for a 10.6% increase compared to preprcject.

Buses

The number of weekly bus riders increased dramatically in the Diamond Lane's first week of operation, from 5,855 preproject to 12,475. (NOTE: Cnly patrons of the Southern California Rapid Transit District and the Santa Monica Municipal Bus Lines are included in this analysis. Excluded are riders of Greyhound, charter buses, and other commercial carriers.) Further, steady increases in bus riders were registered through the 9th week, when the number stood at 17,885, for an average increase of 676 riders per week. From the 9th to the 15th week the rate of increase was lower, averaging an additional 225 riders per week, to total 19,235 person-trips made by bus. From the 15th to the 21st week patronage fell slightly, to 18,965 bus riders weekly.

On a daily basis, an average of 1,171 trips were made on buses prior to the project, compared with 3,879 in the 16th week and 3,793 during the 21st week (see Figure B-3).

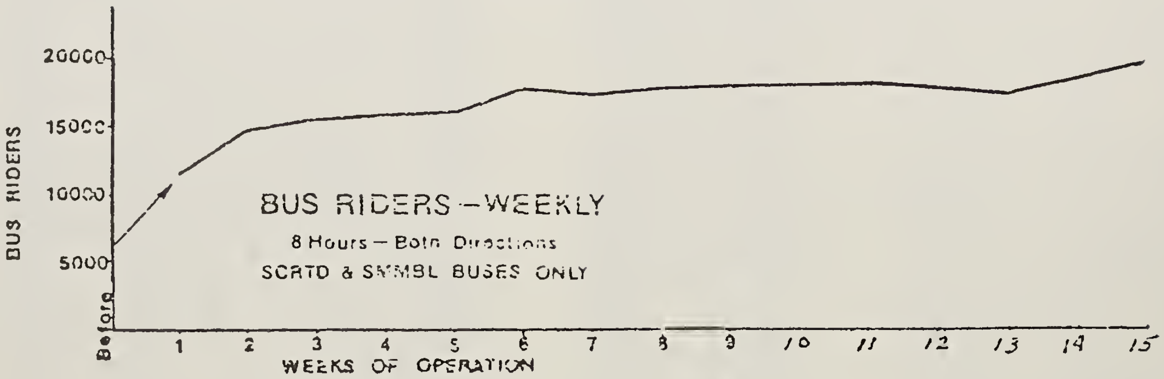


FIGURE B-3. AVERAGE DAILY PEAK PERIOD BUS RIDERSHIP ON ALL SANTA MONICA FREEWAY PROJECT ROUTES IN THE PEAK DIRECTION OF TRAVEL ONLY

Overall, bus riders tripled as a share of all travelers on the freeway in the daily peak period from one percent to three percent at the termination of the project.

There were some significant differences between the contributions of the Southern California Rapid Transit District (SCRTD) and the Santa Monica Municipal Bus Line (SMMBL) to bus ridership numbers. Prior to the project, only the SCRTD provided Santa Monica Freeway service (with 35 trips daily and average weekly ridership of 5,855). SCRTD's share of patronage was much higher than SMMBL's share in the early weeks of the project and remained so throughout the project.

During the first 10 weeks of the project SCRTD made generally 160 bus runs daily. This was increased to about 166 during weeks 11 to 15. Over the 7 succeeding weeks the total daily SCRTD bus runs dropped to 131. SMMBL operated between a low of 20 bus runs daily in the 7th week and a high of 25 bus runs in the 21st week.

Early patronage trends for the two bus lanes were very different. From the first to the 9th week of the project, patronage on SCRTD buses increased by 32 percent, while the SMMBL patronage, which was new ridership, amounted to 100 percent. Significantly, however, in the period from the 9th to the 15th week the rate of increase in patronage for the two bus lines was the same, with each line counting eight percent more passengers in the 15th than in the 9th week.

However, from the 15th through the 21st week, SCRTD patronage dropped to 13,660 or slightly over 4% while SMMBL continued to increase at the same 8% rate to reach 5,375 patrons during the 21st week. Since SCRTD cut its bus service by a weekly average of 89 trips a week after the 15th week (as part of an overall budget adjustment) and increased its fares at the same time, some reduction in patronage was expected.

Bus occupancy numbers continued to differ between the two lines. Prior to the Diamond Lane project, SCRTD buses using the Santa Monica Freeway were 70 percent occupied on the average. With the addition of a substantial amount of new service, occupancy dropped in the first week to 25 percent. The occupancy rate since that time slowly but steadily increased, amounting to 35.6 percent during the 15th week. The SMMBL, in contrast, began operating on the freeway in the first week of the Diamond Lane project with an occupancy rate of 43.4 percent. That rate in the 15th week had increased to 90.6 percent. By the 21st week SCRTD

had increased its occupancy rate to 41.8% by cutting its number of trips in an effort to utilize its buses more efficiently. SMMBL, however, had a slight drop in its occupancy rate during the 21st week to a still high 86.0% after averaging nearly 98% for the previous 5 weeks.

Diamond Lane Utilization

According to CALTRAN's figures, the total daily vehicles using the Diamond Lanes were 29% of the preproject total. These vehicles carried 85% of the people that had previously used the lanes. Overall, the average number of persons per vehicle in the Diamond Lane before the project was 1.23; in the 21st week, it was 3.56.

At the end of the first week of operation, 4,760 vehicles were using the Diamond Lane daily; by the end of the 21st week, this had risen to 6,300.

Diamond Lane travelers increased from 15,900 in the first week, to a peak of 22,700 in the 15th week. In the 21st week, this had dropped slightly to 22,400 daily. This meant, on the average, that about 450 vehicles were using the Diamond Lane hourly, about half the capacity of the lane.

Bus patronage and carpool use were heaviest between 7:00 and 8:00 a.m. and 4:00 and 5:00 p.m. Eastbound, from 7:00 to 8:00 a.m., nearly as many people were carried in the 21st week in the Diamond Lane (99%) as were carried before the project. The significant point is that these people were carried in 83% fewer vehicles than were needed prior to the Diamond Lane. From 4:00 to 5:00 p.m., westbound, the Diamond Lane carried 6% more people than before the project, using 75% fewer vehicles.

Carpools (Three or More Persons)

The number of carpools (vehicles carrying three or more persons) more than doubled in the Diamond Lane's first week of operation, rising from 1,622 daily before the project to 3,649 daily during the 7-hour peak period during the first week of operation (see Figure B-4). After the rapid rise experienced the first week, the number of carpools generally continued to increase slightly, with some variations, rising to a daily average of 4,604 vehicles at the end of the 14th week. By the 21st week this had dropped slightly, to 4,402 carpools per day, still 271% of preproject levels. These

dramatic increases count only those carpools using the Diamond Lanes.

On a daily basis, prior to the project, carpools constituted less than 2% of all vehicles using the freeway in the 7-hour period. By the 15th week, carpools in the Diamond Lanes alone had tripled this figure to almost 6% of all vehicles. By the 21st week this had dropped slightly, to 5.4%

More importantly, the percentage of persons riding in Diamond Lane carpools as a share of all travelers was significant and rose to a notable percentage during the life of the Diamond Lane. Observations showed that the average 3-person carpool carried 3.37 passengers. Accordingly, approximately 5.1 percent of all travelers using the Santa Monica Freeway during the daily 7-hour period prior to the projects were riding in carpools. By the 21st week, the percentage of carpoolers using the Diamond Lane amounted to 12.8% of all freeway users.

Freeway Accidents

During the project the accident rate dropped substantially, from fifty-nine accidents during project hours during the first week of operation to an average of twenty-five accidents per week from the second through the seventeenth week of operation. However, these rates are significantly higher than those experienced prior to project implementation. The average number of accidents per week during the same hours prior to project implementation was ten, with a range of three to twenty. The increased level of accidents has been a primary concern of those responsible for project operation, and is being studied to determine the underlying causes of the increase.

Violations and Police Deployment

According to CALTRANS traffic counts, the number of violators observed using the Diamond Lanes had decreased as the project progressed to approximately 8% of the vehicles in the lanes, or 500 vehicle per day. The California Highway Patrol (CHP) gradually reduced the number of patrol units assigned to the project area by roughly 50% over the period of the project. The final level of officer deployment approximated that occurring prior to project implementation.

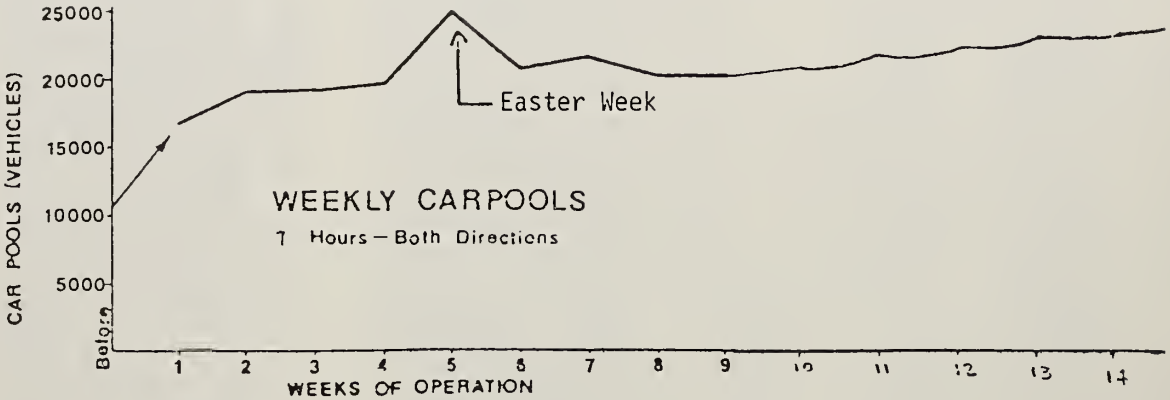


FIGURE B-4. PREFERENTIAL LANE DAILY CARPOOL VOLUMES

Press Coverage and Public Reaction

The local news media adopted a neutral position during the pre-implementation phase of the project. Coverage became negative with implementation and remained so throughout the project's twenty-two weeks of operation.

The public reaction--mostly against the project--was magnified by the negative press coverage, as evidenced by an increase in negative telephone calls following certain newspaper articles. Opinions commonly expressed included:

> Denial of "constitutional rights";
>
> Discrimination against "equal gas taxpayers";
>
> Discrimination against two-person sportscar and motorcycle owners; and
>
> Diamond Lanes should also be for two-person carpools.

Many of the opinions of the public reached project officials through the telephone center, which served as a "lightening rod" for public opinion during the early days of the project. The telephone center received 833 calls during the first day of operation; of these, 604 were negative, 80 were positive, and 45 requested information without expressing an opinion. Later in the first week, the call rate dropped to 200 calls per day. These calls were split roughly 50-50 for and against the project, except on days following adverse press reports, when the level of negative responses increased. Certain people resorted to more radical actions than negative phone calls. On the first day of operation, paint "bombs" were thrown to obliterate the white diamonds in the preferential lane, and nails were thrown into the lane. Shortly after implementation, a lawsuit was filed by a Los Angeles attorney, the driver of a two-seat sportscar, on constitutional and environmental grounds. A second lawsuit was filed by a Sacramento-based public interest law firm and eventually led to the termination of the project.

Evidence of positive public response from people desiring to form carpools took the form of a heavy increase in Commuter Computer applications. In addition to carpool inquiries, a group of "Citizens for the Diamond Lanes" was formed, and several established environmental groups--such as the Sierra Club--voiced their public support of the project.

SUMMARY

After twenty-two weeks of operation the Diamond Lane Project was terminated pending the filing of an environmental impact report by CALTRANS. A comprehensive analysis of the impacts and problems of the Diamond Lanes is underway, but some preliminary observations can be made at this time. Even excluding ramp delays, non-preferential travel times for non-carpoolers were generally greater than pre-implementation travel times with ramp metering. Wait times increased at some ramps and decreased at others. At the end of the 21st week, the freeway carried 102.9% of the pre-project total number of persons in 93% of the pre-project average number of vehicles. Bus ridership and carpooling on the freeway more than tripled over the life of the project. The average number of accidents experienced during the project was more than double the rate experienced before implementation.

While preferential lane treatment on expressways has worked well in other cities where new lanes were added (e.g., Miami), the reservation of two existing lanes on the Santa Monica Freeway resulted in a violent outcry from citizens and the press. This could be attributed to the characteristics of the project area. As a result of the geographic sprawl of the city, Los Angeles residents generally travel further and are more dependent on their automobiles than residents of other U.S. cities. The study area is composed of upper income neighborhoods, and most residents have a ready alternative to transit use.

Due in part to the Santa Monica controversy, the San Diego Freeway Diamond Lane project, tentatively scheduled to open in September, has been delayed.

REFERENCES

1. Transportation Systems Center, "Background Information for Service and Methods Evaluations," attachment to Procurement Request No. TSC/230-0076-RN, Cambridge, Massachusetts, December 1974.

2. Billheimer, John W. and Roy E. Lave, Evaluation Plan for the Santa Monica Freeway Preferential Lane Project, prepared for the Transportation Systems Center under the Urban Mass Transportation Administration's Service and Methods Demonstration Program, Contract No. DOT-TSC-1084, November 1975.

3. State of California Department of Transportation, Evaluation Report on the Santa Monica Freeway Diamond Lane Project After 21 Weeks of Operation, Los Angeles, California, September 1976.

4. Santa Monica Freeway Preferential Lane Project, Application to the Urban Mass Transportation Administration for a Demonstration Grant prepared by the State of California Department of Transportation, California Highway Patrol, City of Santa Monica, and Southern California Rapid Transit District, April 1975.

APPENDIX C

HOUSTON CORRIDOR IMPROVEMENT PROJECT

PROJECT OVERVIEW

The Houston project (TX-06-0018) consists of a coordinated series of traffic management improvements to three major freeway corridors (North, Southwest, West) in conjunction with a broad range of transit improvements. Each corridor is to receive new park-and-ride lots and CBD-oriented express transit service from one or more points. Currently under study are a contraflow lane for priority treatment of transit vehicles and carpools to be introduced in the North Corridor and alternative priority treatment schemes for the Katy (West) Corridor.

Funding for the demonstration totals $861,745, consisting of $689,396 in federal SMD funds (80%) and $172,349 and local (20%) funds. Allocations by corridor are as follows:

North Freeway	$484,600
Southwest Freeway	121,000
Katy Freeway	107,968

The remaining $148,177 will support the management of the demonstration.

The project schedule calls for introduction of Southwest Corridor park-and-ride service as soon as suitable land can be leased. North Corridor priority facilities and park-and-ride service are to be implemented in early to mid-1978. Timing of Katy Corridor improvements will be determined once improvement plans are established. The demonstration was originally scheduled to end in June 1977, but is likely to be extended.

The SMD project is one component of a comprehensive program of transportation improvements designed to deal with significant congestion on radial freeways and arterials, and a deterioration of air quality due to increased auto use. The overall program includes revitalization of the city's bus fleet, improvements to routes and schedules, implementation of a downtown mini-bus circulator system, and initiation of an areawide carpooling program (called

Carshare). Each item is part of the Houston Transportation Systems Management Element. Funding for the overall program comes from a variety of sources, including city general funds, Federal Aid to Urban Systems (FAUS) funds, funds made available through Sections 3 and 5 of the 1974 National Mass Transportation Assistance Act, the UMTA Service and Methods Demonstration Program (Section 6, 1964 Urban Mass Transportation Assistance Act), and Unified Work Program Funds from UMTA Section 9 and FHWA Section 112.

PROJECT OBJECTIVES AND EVALUATION ISSUES

The Houston SMD Project directly addresses four of the basic objectives of the UMTA Service and Methods Demonstration Program:

(1) Decrease transit travel times;

(2) Increase transit coverage;

(3) Increase transit service reliability; and

(4) Increase transit vehicle productivity.

In addition, the SMD improvements are intended to help achieve four major local objectives:

1. Decrease travel time and reduce congestion in the corridors;

2. Raise vehicle occupancy levels in the corridors by shifting urban travel from low to high occupancy vehicles and by increasing the present auto occupancy levels;

3. Achieve a 7.5% reduction in automobile vehicle miles traveled (VMT) in accordance with EPA regulations; and

4. Encourage acceptance and usage of public transportation.

The project evaluation will also focus on a number of operational issues arising out of the demonstration innovations. Specifically, the operation of priority facilities will be monitored to document operational procedures and problems and to determine any important impacts unrelated to overall project objectives.

PROJECT DESCRIPTION

Houston, Texas, is presently the fastest growing and the fifth most populated city in the United States, with an estimated 1,476,000 residents. Unlike many cities, Houston's CBD is experiencing a period of substantial growth, with a significant quantity of high-rise construction. The city-owned transit system, known as Houtran, presently operates 417 vehicles over 30 major routes encompassing 220 individual route spurs. Eight routes operate (at least partially) as expresses on freeways. Nevertheless, regardless of their destination, the vast majority of Houston's commuters travel to work by private automobile. About 85% of these commuters drive alone. The result is that Houston is experiencing significant congestion on its major freeways and arterials leading to the CBD, and air quality has deteriorated to the point where the Environmental Protection Agency has proposed ordering the city to decrease total vehicle miles of travel within its boundaries by 7.5%. In an effort to deal with these problems, as well as to provide improved and more extensive public transportation to its citizens, the city of Houston has embarked upon a comprehensive program of transportation improvements.

The Houston Service and Methods Demonstration Project consists of coordinated improvements to three major freeway corridors; Southwest, North, and Katy (see Figure C-1). All three will receive CBD-oriented express transit service from new park-and-ride lots. The North Freeway will also be the site of a contraflow lane for priority treatment of carpools and transit vehicles; priority treatment for the Katy Freeway is under study. The project is intended to exemplify the impacts achievable through implementation of a broad range of coordinated improvements. The SMD corridor improvements are expected to interact with other program elements to produce impacts greater than those which would result from individual improvements implemented in isolation.

The first SMD park-and-ride service is to be introduced in the Southwest Freeway Corridor, which serves an area of rapid land development, including the Greenway Plaza business-commercial-residential complex, a second regional shopping center at Sharpstown, several industrial parks, and the Houston Baptist College. Plans call for the leasing of parking spaces in an existing lot, such as at a shopping center, and the implementation of peak period express bus service on approximately 20 minute headways operating directly into the CBD. Congestion on the freeway during

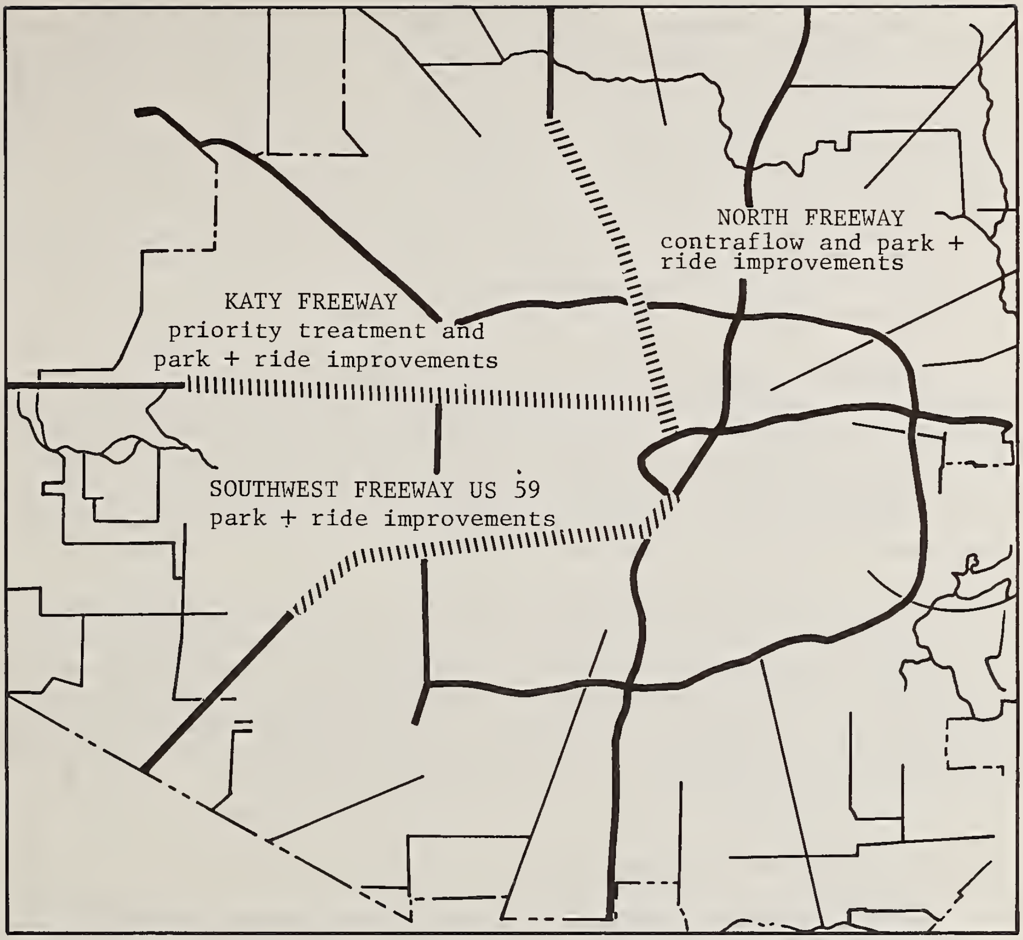


FIGURE C-1. HOUSTON FREEWAY CORRIDORS

peak periods is severe, with volume to capacity ratios ranging up to 0.95 on the sections where buses are expected to operate.

Non-priority ramp signals were installed (August 1975) in this corridor by the State Department of Highways and Public Transportation (SDHPT) on both inbound and outbound ramps to improve traffic flow. Consideration will be given to preferential freeway entry for park-and-ride buses after express service has been established.

The North Freeway, which serves a corridor containing widely varied residential communities, a regional shopping center, and the city's international airport, was selected for the first contraflow lane operation planned for Houston. Because this freeway has the worst peak period congestion in Houston and a significant imbalance between inbound and outbound traffic volumes, it makes a good candidate for contraflow operation. Plans call for possible utilization of the 8.1-mile lane by transit vehicles and carpools on an integrated basis; this would be the first mixed use of a contraflow facility in the nation.

New peak period park-and-ride express bus service to the CBD is planned to take advantage of the contraflow lane, and some existing bus routes will also be diverted onto the facility. The city has received approval of plans to use Urban Systems funds for the purchase and construction of a park-and-ride lot in this corridor, to be located near the outer end of the contraflow lane.

The third corridor scheduled to see improvements under the Service and Methods Demonstration Program is the Katy Freeway Corridor, which serves a variety of residential and commercial developments. It also experiences severe peak congestion. A park-and-ride lot and peak-period express bus service to the CBD are planned to coordinate with some kind of priority treatment to be determined later.

PROJECT HISTORY AND STATUS

As originally formulated, the Houston SMD project consisted of improvements to four freeway corridors. In addition to the current SMD plans in the North, Katy, and Southwest Corridors, the original plan called for the Katy Freeway to receive a contraflow lane similar to the one still to be implemented in the North Corridor. The Gulf Freeway, which connects the CBD with a number of major activity centers to the southeast, was also slated for both

park-and-ride express bus service and installation of a preferential ramp control system to favor carpools and transit vehicles. Television camera surveillance, coupled with a computerized ramp metering control system (non-priority), has been used by SDHPT for a.m. peak inbound traffic for several years with notable success; the SMD project called for signalization of an additional eight inbound and seven outbound ramps to provide free-flow access by high-occupancy vehicles while others were delayed.

The first SMD improvement was to be the establishment of a park-and-ride lot with express transit service in the Southwest corridor. This has so far been precluded by Houston's inability to locate and lease suitable land for the desired lot. Negotiations between the city and owners of the originally chosen location (Westwood Fashion Mall) were carried on for months but proved fruitless. During this period the city held discussions with a number of other land owners, also without success. Some consideration was given to having the city purchase suitable land, but it chose to continue to pursue lease opportunities. In the immediate future, attempts will be made to introduce several small park-and-ride lots along existing transit routes, as well as to seek larger lots which would justify new express bus service. Similar approaches are planned for the Katy and North Freeway corridors. The plans for priority treatment facilities were also plagued with delays. In late fall of 1975, the city began arrangements to have SDHPT perform engineering and design studies for priority treatment to be introduced on the North and Gulf Freeways. On December 15, 1975, the City Council gave final approval of the contractual agreements following delays associated with development of a mutually agreeable contract and subsequently by the need to obtain both FHWA and UMTA approvals before the studies could proceed. On February 13, 1976, members of the city's Office of Public Transportation met with representatives of SDHPT to discuss the preliminary findings, which indicated that construction and operation of the North Freeway facility alone would cost almost as much as was previously budgeted for all four corridors. In addition, the facility would not be ready to open until approximately a year later than originally scheduled. With respect to the Gulf Corridor, the study indicated that interference from planned major construction made the service improvements inappropriate. This conclusion led to the cancellation of all SMD improvements in this corridor.

Prior to its study of the North Freeway contraflow lane, SDHPT had questioned the suitability of such a lane for the Katy Freeway, leading to consideration of other

improvements for this corridor. In June, SDHPT began a 90-day study of possible alternatives. While it is doubtful that a contraflow lane will be recommended, some other priority treatment for buses and carpools (such as an exclusive with-flow lane) is considered likely, in conjunction with CBD-oriented express bus service from new park-and-ride lots.

APPENDIX D

ROCHESTER INTEGRATED TRANSIT DEMONSTRATION PROJECT

OVERVIEW

The Rochester Integrated Transit Demonstration (RITD) consists of the integrated operation of fixed-route with demand-responsive and other "personalized" bus services (called PERT -- PERsonalized Transit) in order to provide improved transit service to the metropolitan area of Rochester, New York. The significant integrated innovations include route rationalization (providing fixed-route or demand-responsive service where and when each is most effective and efficient), transfer coordination, and special prearranged services for the transit-dependent and commuters. Computerized scheduling and dispatching, in addition to digital communications equipment, are being tested to determine their impact on service and productivities.

The demonstration is being conducted by the Regional Transit Service (RTS), an operating subsidiary of the Rochester-Genesee Regional Transportation Authority (RGRTA). The Massachusetts Institute of Technology's (MIT) Department of Civil Engineering serves as a consultant to the RGRTA.

Funding and Sources

The funding levels and sources are:

Planning and Operations

UMTA (Grant NY-06-0048)	$2,598,200	71%
RGRTA	1,048,400	29%
Total	$3,646,600	100%

Capital Equipment

UMTA (Grant NY-03-0075)	$686,400	80%
RGRTA	137,040	16%
State of New York	34,560	4%
Total	$858,000	100%

The planning and operations budget is divided into the following categories of expenditure:

Transit operating costs	$3,091,400
(Farebox revenues)	(-1,486,700)
Computer control	492,000
Project management and liaison	431,980
Fare, service and marketing experimentation	196,038
Data collection and evaluation	144,200
System integration	126,208
Marketing and promotion	114,472
Special markets development	57,236
Transfer and information station development	50,048
Management and information system	28,618
Contingencies	331,500
Total	$3,646,600

The demonstration is scheduled for the period from April 1, 1975 to June 30, 1977. PERT operations predated the demonstration period, beginning operation in the northwest suburb of Greece in 1973. Expansion of many-to-many and other demand-responsive PERT services in Irondequoit (a neighboring suburb of Greece) began on April 12, 1976.

OBJECTIVES AND EVALUATION ISSUES

Local, National and SMD Objectives

Nearly all of the innovations being implemented in Rochester have impacts on all five of the SMD objectives. The greatest effects are anticipated to be on transit coverage, productivity, and services to the elderly and handicapped.

From the local viewpoint, the major effort in Rochester is to establish a unified public transportation system that effectively utilizes several types of bus service. To accomplish this, the following five project objectives have been identified by the Rochester-Genesee Regional Transit Authority in the demonstration proposal:

- Increase the level and quality of transit service;
- Balance peak, off-peak, and evening services to improve the utilization of resources;
- Increase transit coverage (through system adjustment);
- Provide meaningful service for the elderly and partially handicapped; and
- Develop a system for providing easy transfer between the various elements of the transit system.

In addition, the project has been designed to:

- Test the use of a computerized dial-a-ride scheduling and dispatching system;
- Test the effectiveness of various dial-a-ride operating strategies; and
- Test the effectiveness of various transit promotional and marketing techniques.

Key Issues to be Examined

The primary purpose of the Rochester Integrated Transit Demonstration is to identify the role of demand-responsive transit services in a regionwide integrated transit system. PERT operates primarily in low-density suburban areas, many of which have not been well served by fixed-route buses. In these instances, the question is whether PERT can extend the coverage of public transit and attract new riders to the system. Other areas have been served fairly well by fixed route buses resulting in the development of particular land use and travel patterns. In these instances, the question is whether demand-responsive services are more cost-effective than the fixed-route services. User acceptance of demand-responsive services as a replacement for or an

extension of fixed route services is a key indicator of the success of the service integration strategy.

A secondary issue is the determination of the effectiveness of computerized scheduling and dispatching as a means of providing an improved level of service capable of attracting new riders to public transit, while at the same time increasing the productivity of the transit system.

PROJECT DESCRIPTION

Site Characteristics

Rochester. The City of Rochester (Figure D-1) is located approximately midway on the southern shore of Lake Ontario. Its central business district is about six miles south of the lake along the Genesee River which divides the city. Rochester's 1970 population was 296,233, which represents an 11% decline from 1950. It is estimated that its population has stabilized at about 293,000. The entire SMSA (Standard Metropolitan Statistical Area), however, has been steadily growing and was 951,516 in 1970. The Rochester urbanized portion of the SMSA was 601,361 at that time.

The Rochester metropolitan area is the principal home of two major corporations: Kodak and Xerox. Kodak Park East in northwest Rochester on the Greece border employs 22,000 persons and is the largest single employer outside the Rochester CBD. Considerable project attention has been given to providing transit service to Kodak facilities.

The primary travel patterns for the two service areas considered in the demonstration (Greece and Irondequoit) are associated with the Rochester CBD, major employers, and the large shopping areas in these suburbs. This transportation demand has historically been met by automobiles and, to some extent, fixed-route buses.

Greece (Figure D-2). PERT dial-a-bus service was initially instituted in a 10.1 square mile service area in the suburban town of Greece plus a part of northwest Rochester. Approximately 52,000 persons resided in the service area at the time PERT dial-a-bus service was instituted. Four expansions have subsequently been made, the most recent in September 1975. This has resulted in a 15.2-square-mile-service area consisting of approximately 70,000 people.

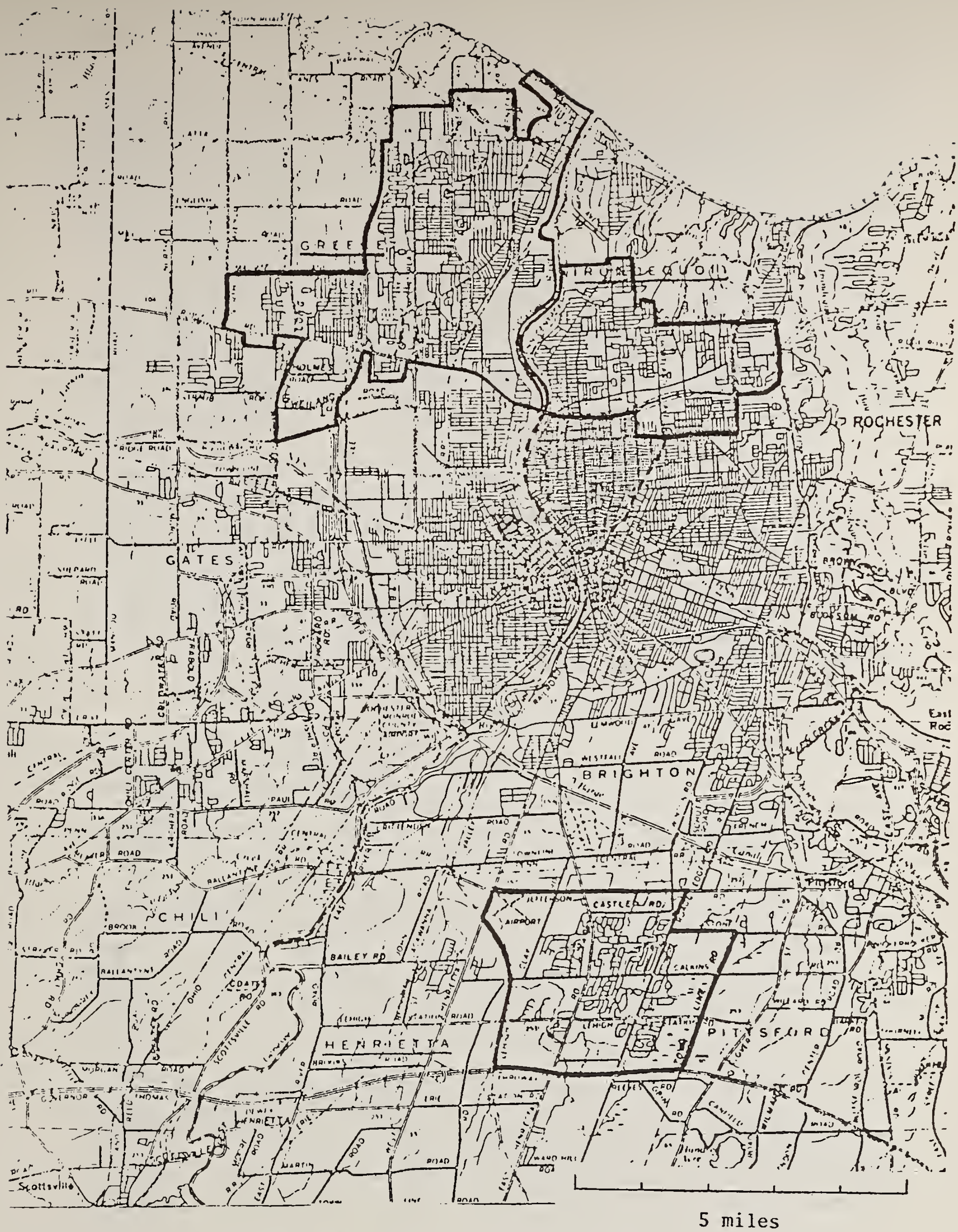


FIGURE D-1. PERT SERVICE AREA

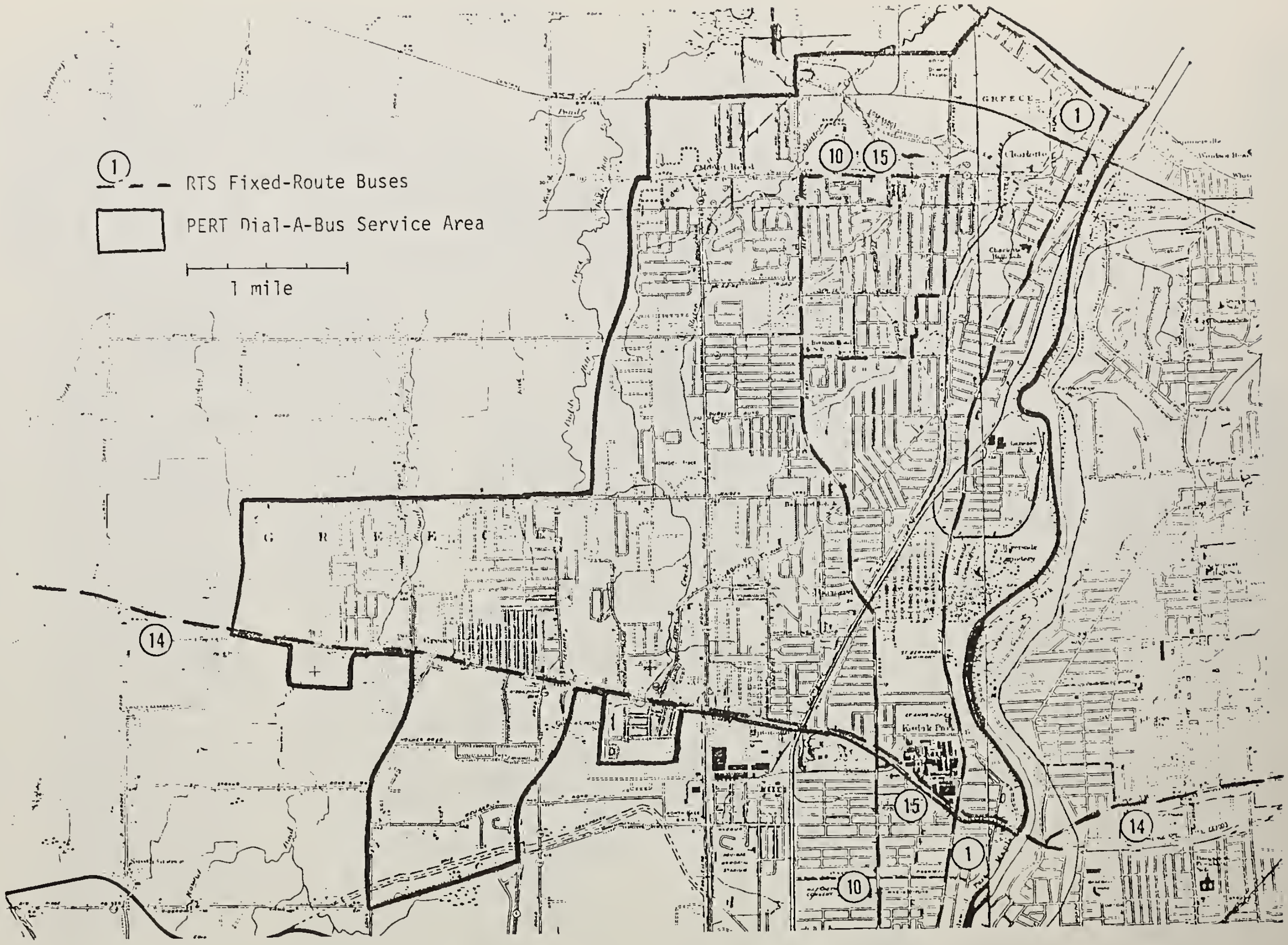


FIGURE D-2. GREECE PERT SERVICE AREA

Prior to the introduction of PERT service, there were four bus routes in Greece; Routes 1, 10, 14, and 15. Routes 10 and 15 follow the same streets within Greece; Routes 1 and 10 are radial routes leading to the CBD; and Routes 14 and 15 are circumferential. As can be seen in Figure D-2, much of the dial-a-bus service area does not have convenient access to a fixed-route bus.

Irondequoit (Figure D-3). Unlike Greece, the Irondequoit service area is not clearly defined, since there is no unique service area which encompasses all of the PERT services. The town of Irondequoit includes 63,684 persons, although a smaller area with approximately 40,000 persons is served by dial-a-bus. Checkpoints near the service area effectively enlarge the population being served.

Demographically, Irondequoit is similar to Greece. Located directly east of Greece, it consists of predominantly single-family, owner-occupied housing, with automobile ownership and income above the SMSA and national averages. The area is better served by public transportation than Greece; nine fixed-route buses traverse the area, three of which run only during peak periods. Certain areas in the northern and eastern portions of the town, however, are beyond convenient walking distance to bus routes.

Services and Innovations - Greece

Greece services currently consist of integrated fixed-route bus and dial-a-ride bus operations, subscription services, group trips, and service for the handicapped.

There are two types of integration of the fixed and demand-responsive services, i.e., route rationalization and transfer coordination. Non-service innovations include those classified as equipment innovations, e.g., vehicles, computerized scheduling and dispatching, and communications equipment. In addition, fare promotions and user information innovations are included in this category.

Fixed-Route Service. Four fixed-route bus lines serve Greece; three running north and south, and one running east and west (see Figure D-2). These routes have existed for some time, and land use patterns have probably been affected by them. Almost 48% of the Greece service area population is within one-quarter mile of one or more of these routes.

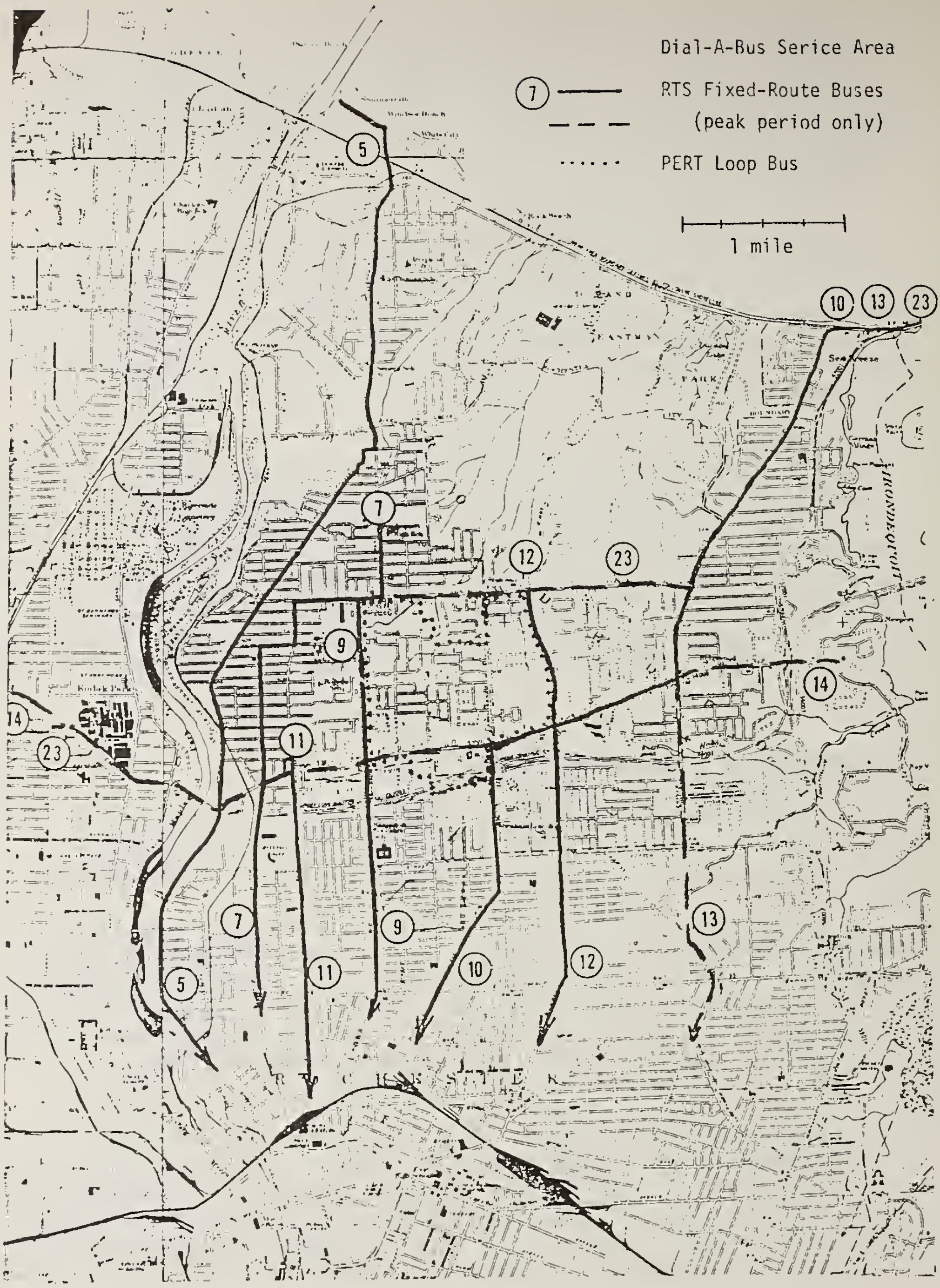


FIGURE D-3. IRONDEQUOIT PERT SERVICE AREA

As part of the integration strategy, some of these routes have been cut back during the offpeak period (see Route Rationalization and Transfer Coordination).

Dial-A-Bus. Dial-a-bus (DAB) is a user demand-responsive form of bus service. Customers use dial-a-bus by telephoning the PERT control room and giving the telephone operator the relevant trip information: name and telephone number, origin, destination, and desired time of departure. Requests are classified into "immediate" requests (the customer wants to travel as soon as possible) and "advance" requests (the customer books a trip for later in the day or week). DAB is used in two ways: Customers may use the service in a many-to-many mode (that is, from any origin to any destination in Greece), or they may use DAB as a means of access to one of the fixed routes.

DAB service was initiated on August 6, 1973 in a 10.1-square-mile service area. Service was offered from 8:15 a.m. to 5:30 p.m. on weekdays for a one-way fare of $1.00 ($.50 for the elderly during the offpeak period). Additional passengers were $.25 and transfers to a fixed-route bus were $.05. Since the initiation of DAB service, many of these service parameters have undergone changes. The service area was expanded on four occasions so that by September 1975, a 15.2-square-mile area was covered. Concurrent with the first service area expansion in June 1974, the operating hours were extended to cover the period from 7:30 a.m. to 10:15 p.m. on weekdays and 8:45 a.m. to 7:45 p.m. on Saturdays. Route 14 service was eliminated during the offpeak period at this time. In January 1975, a $.50 fare to and from the Dewey and Ridge transfer point was instituted between 9:30 a.m. and 3:30 p.m., coinciding with the cutback of Route 10 fixed-route service.

In addition to providing the means by which computerized scheduling and dispatching could be tested, dial-a-bus in Rochester represents an attempt to extend coverage by operating demand-responsive service in a major metropolitan area in coordination with fixed-route services.

Home-to-Work Subscription Service. Subscription services are used to serve demands which can be aggregated from a few origins to a few destinations to provide reliable, fast service with high productivity.

Home-to-work subscription service during peak periods to Kodak Park East began in August 1973, and was extended to include the 7:00 a.m. and 8:00 a.m. shifts at Rochester Products in May and September 1974, respectively. The

PERT Dial-A-Bus Providing Door-to-Door Service, Rochester, New York

Shopping Trips Provided by Dial-A-Bus Service, Rochester, New York

service area in which pick-ups are made has generally corresponded to the dial-a-bus service area, although certain area expansions occurred for subscription service prior to dial-a-ride expansion. A weekly ticket (ten trips) costs $7.00 and a single trip costs $.80. Reservations must be made by 2:00 p.m. on the day preceding the trip.

Feed-a-Bus Service. Feed-a-bus subscription service is closely related to work subscription service, as passengers of both services can be served by the same bus runs. This service, which began in August 1973, takes a peak period passenger to and from a transfer point for an RTS fixed-route bus. These transfer points are at Dewey and Ridge (Route 10) and Lake and Ridge (Route 1). Since both locations are in the vicinity of Kodak Park East, a feed-a-bus is combined with work subscription service to that facility. The weekly fare is $7.50 (ten trips including transfers), with a single trip fare of $.85.

Home-to-School Subscription Service. School subscription service began with the start of the school term on September 10, 1973. A weekly ticket booklet costs $5.00, a four-week booklet costs $16,00, with a single trip fare of $.65. As with the other subscription services, reservations are required by 2:00 p.m. on the day preceding the trip.

Special Trips. Special trips are those arranged for a group traveling to a common destination. The first such service began in January 1974, and was a once-per-week shopping service to Northgate Plaza for residents of the Lakeview Towers housing development for the elderly. Since that time more groups have taken advantage of the service, and there are now 200 to 250 special passengers on ten to fifteen trips per week. Fares vary, depending upon the specific service arrangements. In some cases an outside organization, such as a department store, will subsidize the operations.

Services for Handicapped. In April 1975, a bus equipped with a wheelchair lift was placed in service, which enabled persons confined to wheelchairs to use regular dial-a-bus service in Greece. During the offpeak period the same reduced fare structure as for the elderly is applicable. Starting on June 16, 1975, "special handicapped service" began, and disabled passengers from the Greece service area and from Irondequoit could travel to any of a dozen locations in the Rochester CBD for $2.00 ($.25 for each additional passenger). The locations served are predominantly health and social service facilities.

Route Rationalization. Route rationalization is the replacement of fixed-route service by flexible-route service during periods of low demand. It is hypothesized that demand-responsive service may offer a higher level of service and operate more cost-effectively under such conditions. In addition to improving productivity, the intent of route rationalization is to make transit services more attractive and available to a larger population. User acceptance of the new services is a key issue. In Greece (Figure D-2), this innovation was first implemented in June 1974, when Route 14 service along Ridge Road was eliminated during the offpeak period. In September 1974 and January 1975, Routes 10 and 15 along Dewey Avenue were successively cut back to Ridge Road during the offpeak period. In January 1975, when midday service north of Ridge Road was eliminated, a midday fixed-route feeder fare of $.50 was instituted on dial-a-bus.

Transfer Coordination. To successfully integrate fixed-route and demand-responsive buses, transfers between the two must take place in a pleasant and effective manner. This requires the coordination of schedules so that transfer times and total travel times are minimized. The provision of comfortable transfer facilities is also desirable.

In Greece, the intersection of Dewey Avenue and Ridge Road (Figure D-2) has been selected as the major transfer point. Efforts to improve transferring between dial-a-bus and fixed-route buses have included the meeting of every other Route 10 bus by a DAB vehicle and the construction of a transfer facility (opened in the fall of 1976).

Fare Innovations. Fare innovations have been used primarily to promote ridership by reducing fares for short periods of time. Several half-fare experiments have been undertaken in Greece with discount coupons and by simply cutting the fares.

Various fares have been employed in Greece. The basic dial-a-ride fare is $1.00, additional passengers ride for $.25 each. Elderly and handicapped passengers ride at a reduced fare of $.50 during the off-peak, and there is a midday feeder fare of $.50 to the Dewey and Ridge transfer point.

Information Innovations. Information innovations are intended to encourage ridership by creating awareness of the services and providing information to facilitate use of the system. Information is provided to users by direct mailings, advertising, via the PERT telephone information

number, drivers, and other riders. Through user feedback, the flow of information is a two-way process.

Trip-specific information is another example of an information innovation. With computerized scheduling and dispatching, a list of passengers subject to pick-up delays is continuously being generated. This enables PERT personnel to contact these passengers in order to update the status of their trip.

Vehicles. PERT service in Greece initially began with seven small Twin Coach buses. Since then, 21 buses made by six other manufacturers have been added to the fleet, including four vehicles with wheelchair lifts. Thus, the Rochester demonstration provides a unique opportunity for comparing buses made by various manufacturers regarding performance and user preference within the same environment.

Computerized Scheduling and Dispatching. In September 1975, phase-in of the scheduling of passengers and the dispatching of buses in Greece began using a computerized algorithm rather than manual scheduling and dispatching. In such cases, vehicle tours are continually being developed and updated by computer. Drivers receive pick-up and drop-off instructions individually from the computer. The proportion of operating time under computer control has grown steadily since the fall of 1975. Once computerized scheduling and dispatching is perfected in Greece, it will be instituted in Irondequoit. Direct comparisons between manual and computerized operation may be difficult for the same and different service areas, since the supply of transit and the demand for services have changed significantly during the period of computer phase-in. The intent of computerized scheduling and dispatching is to improve reliabilty and productivity, reduce travel time, and increase the system's effective capacity beyond that experienced with manual scheduling and dispatching. Computerized operation will also provide additional information for system planning and management.

Communications Equipment. Until the spring of 1976, buses were equipped with digital printers and/or radios for communications with the PERT control room. The buses of the PERT fleet have since had video communications equipment installed. Thus, three different modes of communication can be compared. The questions to be answered concern how system productivity and reliability can be enhanced by better communications.

Computerized Control Center, PERT Dial-A-Bus,
Rochester, New York

PERT Dial-A-Bus Vehicle, Rochester, New York

Services and Innovations - Irondequoit

Many of the services introduced in Irondequoit were similar to those in Greece. The vehicle and computerized scheduling and dispatching innovations apply to both areas. The rationale for these innovations described in the above section on Greece are therefore not repeated here.

Fixed Bus Routes. Irondequoit is served by nine fixed bus routes, running primarily in a north-south direction (Figure D-3). Other services described below have been designed to be integrated with these fixed-route services.

Route Deviation. Route deviation is essentially a fixed-route service in which some deviations from the route will be made at the user's request. The intent of route deviation is to provide coverage approaching a many-to-many demand-responsive system while retaining the productivity and reliability of a fixed-route system.

Route deviation is being tested in Irondequoit in two ways. During the night, Routes 5, 7, and 9 (Figure D-4) deviate from their routes to pick-up or drop-off passengers at their homes for an additional fare. During the day, the Summerville Shuttle deviates at several locations for an additional fare.

Dial-A-Bus. Dial-a-bus service is intended to extend transit coverage more cost-effectively than an extension of the fixed routes. Irondequoit service began operation on April 12, 1976 in a five-square mile area in the southern portion of Irondequoit. The initial operating hours were 8:00 a.m. to 10:15 p.m. on weekdays, and 8:45 a.m. to 7:45 p.m. on Saturdays. Beginning on June 21, 1976 service ended at 7:00 p.m. due to low evening demand. As in Greece, the fare is $1.00, $.50 for the elderly and handicapped during the offpeak period, and $.25 for additional passengers. Transfers are $.05.

Loop Bus. Within the dial-a-bus service area, a loop bus with a 45-minute headway connects most of the major activity centers, including Irondequoit Plaza, Two Guys' Plaza, Rochester General Hospital, Wilson Health Center, Town Hall, and Keeler Towers. The intent of the loop bus is to extend the coverage of the fixed-route system by providing a circulation component connecting these activity centers with all of the fixed-route buses.

The loop bus hours initially were from 9:30 a.m. to 3:00 p.m. on weekdays, and Saturdays from 9:00 a.m. to 6:00

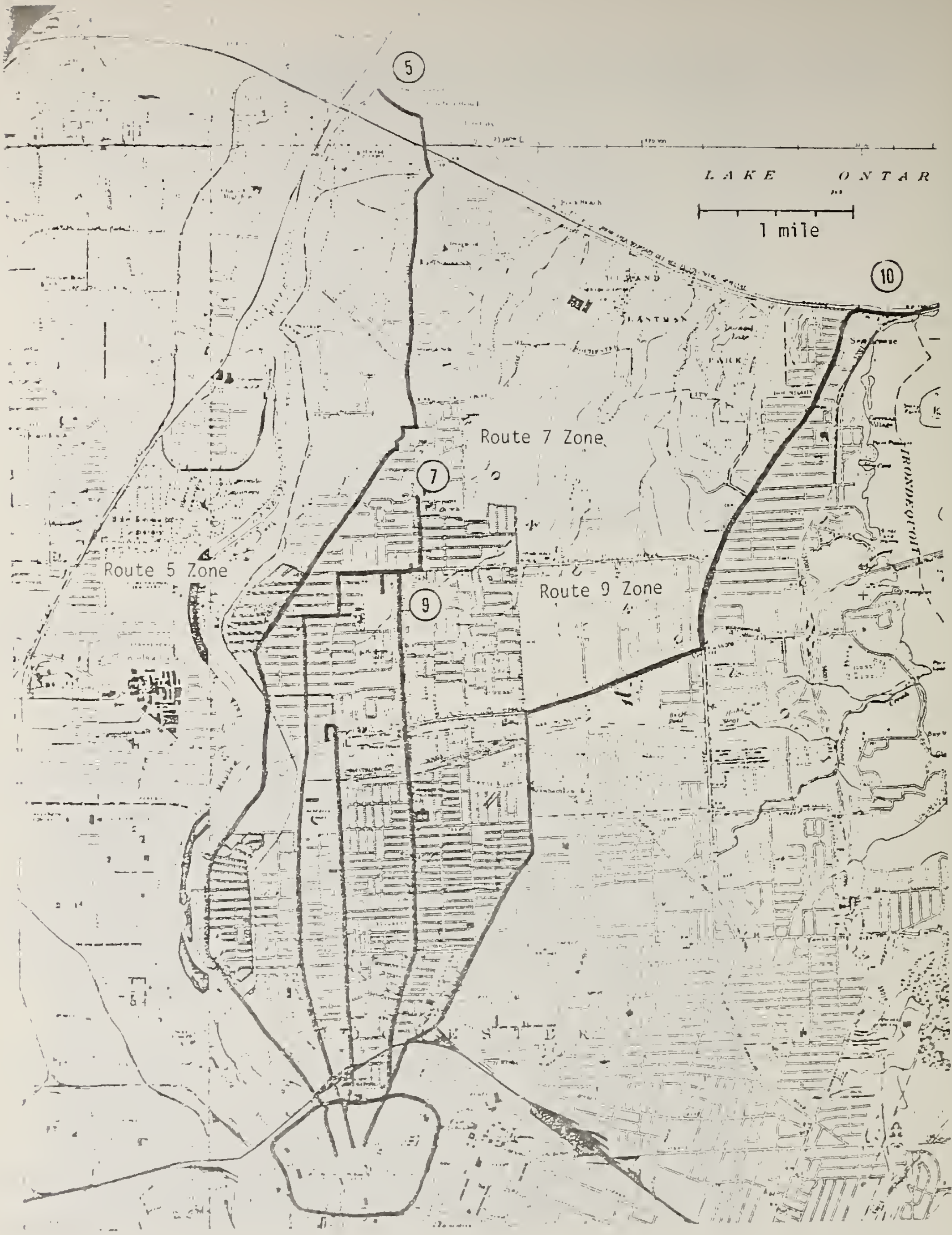


FIGURE D-4. URBAN PERT SERVICE

p.m. Weekday operating hours shifted to 10:00 a.m. and 4:00 p.m. on June 21, 1976. The fare is $.25 and $.20 for the elderly and handicapped. During the time the loop bus is operating, Routes 9 and 12 (which coincide with the loop bus route) are cut back to the Ridge Road area. Passengers may transfer to the loop bus for an additional $.05.

Summerville Shuttle. Prior to April 12, 1976, one of every three midday and early evening Route 5 buses continued past Ridge Road to Summerville. Beginning on April 12, 1976, all midday, evening and Saturday buses have turned around at Ridge Road. A PERT shuttle bus meets every third Route 5 bus at Ridge Road. Route 7 buses also turn around at Ridge Road during this period. The shuttle bus follows the Number 7 route to Irondequoit Plaza and then travels north on Cooper Road until it returns to the Number 5 route along St. Paul Boulevard. In this way, persons along the St. Paul Corridor may travel directly to Irondequoit Plaza. In addition, two bus deviation points off the route in northern Irondequoit were established to pick up or drop off passengers on demand. Additional deviation points were added in June 1976 in the St. Paul Boulevard area of southern Irondequoit.

The intent of the shuttle is to extend coverage while maintaining acceptable productivity levels.

Urban PERT. After 9:00 p.m. each night of the week, Routes 5, 7, 9, and 10 are operated with PERT vehicles (Figure D-4). In addition, Routes 7, 9, and, to a lesser extent, Route 5, have accompanying dial-a-bus zones associated with their routes. Thus, passengers may be picked up or dropped off anywhere in the area bounded by Portland Avenue, the Inner Loop, St. Paul Boulevard, and Titus Avenue for $1.00, or they may use the regular fixed-route bus stops for $.30. A small area north of Titus Avenue is similarly covered (Figure D-4).

This service is essentially a dial-a-bus operation for late-night service in Irondequoit and the urban Rochester area. It is intended to extend coverage of the system and to provide service with a higher level of user security.

Subscription Services. Two subscription routes began operation in Irondequoit on April 12, 1976. One route runs through the St. Paul Boulevard corridor to Kodak Park, and the second brings retarded persons to a day care center on Ridge Road East. Both buses use a system of designated stops for picking up and dropping off passengers, rather

than providing every home with door stop service. A $5 per week fare is charged for the service.

Route Rationalization. In Irondequoit (Figure D-3), route rationalization is demonstrated by the cutback of midday service on Routes 7, 9, and 12 to the Ridge Road area. However, additional fixed-route service (such as the loop bus and Summerville Shuttle) provide fixed-route alternatives to the services that are cut back. Thus, there is not a simple replacement of service in Irondequoit, but rather the fixed-route services are consolidated and dial-a-bus is offered to supplement the fixed-route system.

Fare Innovations. Fare innovations in Irondequoit consist of service level fares in the route deviation service. On the late-night Urban PERT system (Routes 5, 7, and 9), passengers may pay $1.00 for service to their homes or $.30 for service to the regular fixed-route bus stop. Similarly, the Summerville Shuttle will deviate to the two specific stops for an additional $.10, free to the elderly and handicapped.

HISTORY AND STATUS

Transit Development

The Regional Transit Service (RTS) was formed in 1968, when the City of Rochester purchased the Rochester Transit Corporation. In 1970, the four-county Rochester-Genesee Regional Transit Authority (RGRTA) was created, which purchased the RTS from the City of Rochester.

Although transit operations have been the responsibility of several organizations in recent years, a strong tradition of transit innovation exists. Exclusive bus lanes were established downtown in the 1930's. In 1954, the Rochester Transit Corporation became the first totally radio-equipped transit system in the world. More recent innovations by the RGRTA include the development of many highly productive "park-and-ride" routes, the 1971 establishment of a dial-a-bus system in Batavia (forty miles southwest of Rochester), and the creation of a free-fare zone in downtown Rochester in 1974. In August 1973, demand-responsive PERT service was instituted in the suburban town of Greece which later evolved into the Rochester Integrated Transit Demonstration.

The year 1975 marked a significant change in the political climate in Rochester. The financial problems of

New York City and New York State had an impact on transit operations in Rochester. New York State transit subsidies were delayed, creating a financial crisis within RGRTA. Significant opposition to the transit authority was forming within the county legislature. Bills were introduced and debated in the legislature that would have abolished the RGRTA. Within this setting, the Rochester Integrated Transit Demonstration is being conducted. In late 1975 and early 1976, PERT was expanding services while RTS was contemplating substantial fixed-route service cutbacks. (The demonstration was adequately funded principally through federal funds, whereas fixed-route bus services rely partially on local and state subsidies.) To compound the financial and political situation, the RGRTA Executive Director, who was the principal proponent of DAB, resigned in early 1976. This resignation resulted in a management crisis within the transit authority and negatively impacted the demonstration.

Demonstration Plan

A chronology of the major events of the Rochester Integrated Transit Demonstration include the following:

August 6, 1973	PERT service begins in Greece, including dial-a-bus and work subscription service to Kodak Park; service area = 10.1 square miles; population served = 52,000; fleet size = 7 vehicles.
September 10, 1973	School subscription service begins.
January 24, 1974	First shoppers' special is operated.
May 28, 1974	Work subscription service to Rochester Products begins.
June 24, 1974	Service area expanded and dial-a-bus operating hours extended; Saturday service begins; Route 14 service cut during the offpeak period.
September 9, 1974	Route 10 service cutback to Northgate Plaza during midday; to Ridge Road at night and on

	Saturdays; and service area expanded.
November 4, 1974	Service area expanded.
January 6, 1975	Route 10 service cut to Ridge Road during midday; $.50 midday feeder fare incorporated; thirteenth PERT vehicle (the Electrobus) acquired in joint cooperation with Rochester Gas and Electric.
April 1, 1975	Demonstration officially begins.
April 7, 1975	Handicapped service begins.
June 16, 1975	RTS offpeak fares reduced to $.25; special handicapped service begins; transit fares in Rochester inner loop are eliminated.
September 8, 1975	Service area expanded to 15.2 square miles.
September, 1975	Computerized scheduling and dispatching phase-in begins in Greece.
December, 1975	Severe vehicle breakdowns begin to be encountered.
January-February, 1976	Promotion with half-fare coupons mailed.
April 12, 1976	PERT service begins in Irondequoit, including dial-a-bus, work and day care subscription services, and route deviation services; Urban PERT offers late night route deviation in Rochester-Irondequoit corridor.
May 10, 1976	RTS fares raised to $.50 during peak periods and weekends, $.30 during offpeak periods.
June, 1976	Full-time computer operation with digital communication equipment.

Modifications to Demonstration

Demand-responsive services in Rochester were initiated nearly two years prior to the start of the demonstration. In Greece, prior to the demonstration, the dial-a-bus service area had been expanded three times. A fourth service area expansion was made after the demonstration began, but was relatively insignificant. Additional service implementations in Henrietta and other areas have been indefinitely postponed, since they would necessarily be into areas of increasingly lower population density, and thus probably lower demand densities.

A major Greece service redesign is scheduled for mid-September that will re-establish modified fixed-route services in the principal transit demand corridors. The many-to-many DAB service area will be reduced by instituting a point deviation collection-distribution service into part of the former many-to-many zone. The Greece and Irondequoit fare structure will be modified at the same time. Fares will be determined on the basis of zonal areas, service provided, and passenger type.

Project Delays and Their Impacts

Several project delays have been encountered thus far in the Rochester demonstration. Computerized scheduling and dispatching of dial-a-bus service in Greece began in September 1975, with the intention of being fully operational by the following winter. A series of problems--including long computer response times, malfunctioning vehicles and communications equipment, a major fire in the contractor's computer center, and certain shortcomings in the algorithm--prevented adherence to the planned implementation schedule. In June 1976, full-time computerized dispatching was finally achieved. During the implementation period some negative impacts on the level of service -- especially for transferring passengers -- resulted from the computer system problems. Since the computerized system has not been fully operational for an extended period, no evaluation results are presently available.

Another delay in Greece has been in the opening of the Dewey and Ridge transfer station for passengers transferring between dial-a-bus and Route 10. Originally scheduled to open in the fall of 1975, the station opened a year late in the fall 1976. A much more modest facility than that originally planned is being constructed.

Irondequoit services began on April 12, 1976, rather than in January 1976, as originally planned. A delay in the delivery of the video communications equipment caused this postponement.

FINDINGS

Results (Greece)

Coverage and Accessibility. PERT services in Greece have made transit available to a much larger population than did the previous fixed-route system. Approximately 52% of the population residing in the present Greece PERT service area lives more than one-quarter mile from a fixed-route bus. By offering door-stop service, PERT provides transit accessibility to the entire population of approximately 70,000 persons. In addition, most Greece residents with access to fixed-route buses were previously required to transfer when traveling to the major shopping malls along Ridge Road. Dial-a-bus now provides direct service. PERT work subscription service also provides access to the General Motors Rochester Products plant, which is not served by fixed-route transit. Finally, special services for the elderly and handicapped provide access to shopping centers and social service facilities.

Travel Time and Reliability. Twenty-six daily service quality checks have been conducted on dial-a-bus during periods of manual dispatching. Sixteen of these service quality checks were taken during 1975 when demand, service area, and vehicle supply were fairly uniform. Average system response time (time from call-in to passenger pick-up) for immediate requests during this period was 25 minutes, including an average six-minute delay between promised and actual pick-ups. Average ride time was about 15 minutes; thus, total travel time by DAB was approximately 40 minutes. For the estimated average DAB trip length of 2.8 miles, this results in a riding speed of 11.2 mph, and a level of service measure of 4.8 (total auto travel time/total transit travel time), using an average assumed auto speed of 20 miles per hour.

In the case of advanced requests, DAB pick-ups average about 8 minutes after promised pick-up time, resulting in a total travel time of 23 minutes. The overall travel speed of these trips would thus be 7.3 miles per hour, with a level of service measure of about 2.7. Approximately 40% of the passenger requests are advance requests.

System stability (supply-demand interactions) is measured by the variation in system response times and ride times. During the sixteen 1975 service quality checks, the daily standard deviation in passenger wait time (system response time for immediate requests) averaged around 15 minutes. There has been considerable variability around the average wait time of 25 minutes. Deviations from promised pick-up times are a measure of system reliability and these also vary considerably. While the average "lateness" in pick-up was between 6 and 8 minutes, the daily standard deviation in lateness was around 12 minutes. This has resulted in considerable uncertainty regarding the time of actual passenger pick-up relative to that promised.

During the winter of 1975-76, severe vehicle breakdown problems have resulted in a general deterioration of DAB level of service. Although there have been only three service quality checks during this period, the results of lowered level of service is further evidenced by an increased number of customer complaints, no-shows and cancellations. The situation improved during the spring and summer; however, it appears that consumer confidence has not been fully restored.

As part of the system integration strategy, special attention has been given to passengers using DAB and transferring to fixed-route buses. Transfer wait times between DAB and Route 10 was measured on three occasions in late 1975 and for a three-day period in May 1976. Average wait times were around 7 minutes when transferring to a fixed-route bus and between 13 and 16 minutes when transferring to PERT. The standard deviation of transfer wait times tends to be between 70% and 80% of the mean, implying high variability in transfer wait times. Furthermore, the average (PERT to fixed-route) transfer wait time is approximately half the fixed-route bus headways, which is what would result if passengers randomly arrived at the transfer point.

<u>Demand</u> (Dial-A-Bus)

During the first year and one-half of DAB service (pre-demonstration), there were three major half-fare promotions, three service area (spatial) expansions, three cutbacks of local fixed-route service during the offpeak period, and service was extended into the evening and Saturdays. Consequently, daily DAB ridership grew during this period from around 175 per day during the first few weeks to around 500 per day. From March 1975 to December 1975, there were

relatively few service changes and ridership remained fairly steady, averaging 476 per day. In December 1975, PERT began experiencing severe vehicle breakdown problems. This caused ridership to decrease during December and January, probably as a result of decreased level of service. Between January and June 1976, the average ridership was 387 per day. This corresponds to an average daily demand density of about 1.8 passengers/square mile/hour, down from 2.2 in 1975.

Excluding school vacation periods, there has been an average of 1.28 passengers per DAB trip. During school vacations there is a greater tendency to use the multiple-passenger option ($.25 for each passenger after the first), and the number of passengers per trip is about 1.46.

Most of the local activity centers, as well as the transfer points to fixed-route buses, are located in the southern portion of the service area along Ridge Road. Approximately 80% of DAB trips begin or end in the Ridge Road area. About two-thirds of these trips have one trip-end in the northern portion of the service area. Thus, DAB travel patterns are predominantly in a general north-south direction, but there is also an identifiable east-west movement along Ridge Road.

Other data on trip and user characteristics are derived from the results of the four DAB on-board surveys. The most recent of these occurred in June 1976, but the data have not yet been fully analyzed. From a two-day on-board survey conducted in June 1975, it was found that DAB riders are highly dependent upon PERT for transport. About one-third of the weekday riders and half of the Saturday riders had no alternative and would not have been able to make their trip without PERT. Although over three-quarters of the riders were from households where an automobile was owned, about two-thirds did not possess a driver's license. DAB ridership is from various age groups and predominantly (three-quarters) female.

Based upon the June 1975 survey, over half of the riders were frequent users, using DAB twice per week or more. About one-sixth of the ridership rode once or twice per month, with approximately 10% using DAB for the first time. Work and shopping trips made up about two-thirds of DAB trips, with work trips exceeding shopping trips on weekdays but shopping trips being the predominant on Saturdays.

Users tended to rate DAB favorably on all attitudinal surveys. Only "promptness in pick-up" was perceived

somewhat negatively with 11% of the users rating it as "poor" or "very poor." One-third of the respondents said they were picked up late, most of them by ten or more minutes. Users tended to underestimate both their actual wait times and their deviations from the promised pick-up times.

Passengers transferring to fixed-route buses from DAB have also been surveyed extensively. A May 1976 survey indicated that there was considerable dissatisfaction with having to use DAB as a result of the elimination of fixed-route services in Greece during the offpeak period. About two-thirds of these transferring passengers were coming or going to points within one-quarter mile of the peak hour fixed-route buses. They indicated a strong preference for using only the fixed-route buses (that were cut as part of route rationalization) rather than using DAB and transferring to fixed route buses.

Demand (Other Services)

Demand for work subscription service undergoes strong seasonal variation, rising during the fall and winter and declining during the spring and summer. The highest levels were reached during the 1973-74 winter, when the perceived gasoline shortage induced temporary increases in transit ridership nationwide. During the past two years, winter ridership has generally been between 150 and 175 passengers per day. There is usually a decline of 25 to 50 passengers per day during the summer. Approximately 90% of the demand is to Kodak Park and 10% is to Rochester Products. Feeder subscription service, in which passengers are carried on the same buses as work subscription passengers, has fluctuated between 5 and 15 passengers per day over the course of the project.

Subscription service implemented in Irondequoit is different from the Greece subscription service. Irondequoit subscription service utilizes the checkpoint pickups rather than doorstep pickups, i.e., the rider must walk a short distance from his home to a checkpoint where more than one person may be picked up and dropped off.

Work subscription passengers were surveyed over the telephone in April 1975. About 75% of the passengers use the subscription service for a roundtrip. About one-quarter of the Kodak Park passengers use PERT even though they are within a quarter-mile of a fixed-route bus that could take them to work at a lower fare. User perceptions of travel

time are fairly accurate and reliability is not perceived to be a significant problem. Eighty-four percent of the surveyed users possess driver's licenses. Automobile ownership is very high; 2.4 per household on the average. Users come predominantly (83%) from households in which there are more workers than cars. Yet, there is considerable diversion from automobiles; about 55% of those surveyed drove to work before switching to PERT and would drive if PERT subscription service were eliminated.

School subscription service generally carries about 80 passengers (40 round trips) per day to four schools in Greece. During early fall and late spring, there is generally a slight decline in ridership. During a two-week school bus drivers' strike in September 1975, ridership increased to 120 passengers per day, limited by the availability of buses.

Ridership on PERT special services fluctuated considerably during the past year, but has generally been between 150 and 200 passengers per week on 8 to 10 regularly scheduled senior citizen specials to Longridge Mall and Northgate Plaza.

Usage of PERT services by the handicapped has also varied considerably since these services began in April 1975. There are some weeks in which no wheelchair-confined persons are transported. During other weeks small groups are transported and there will be twenty or more passengers carried. During one week in December 1975, over 120 trips were made by wheelchair-confined passengers.

Economics and Productivity

For the first two and one-half years of PERT, operating costs have generally been around $16.00 per vehicle-hour. As a result of a drivers' wage increase in December 1975, and vehicle maintenance cost increases due to increased vehicle breakdowns which began at about the same time, operating costs have risen to around $18.00 per vehicle-hour. Capital depreciation costs and the amortization of training costs prior to April 1975 tended to add about $1.50 per vehicle-hour to these costs (about a 10% increase). Since the demonstration began, however, managerial costs have not been included in the above-mentioned operating costs. The Irondequoit start-up costs and transfer stations construction costs have greatly increased non-operating costs during the demonstration. Special planning and evaluation costs associated with the demonstration, as well

as the costs involved with the implementation of computerized scheduling and dispatching, have not been included in any of the cost calculations presented in this report.

Drivers' wages and benefits account for about 45% of total operating costs, vehicle maintenance accounts for 12%, and control room wages and benefits account for an additional 11%. The remaining costs are divided into several other categories.

After an initial growth stage during the first year, DAB vehicle productivity had stabilized during most of 1975 at about five passengers per vehicle-hour. As ridership declined during the winter of 1975-76, vehicle productivity likewise declined. In June 1976, vehicle supply was reduced due to decreased demand, and vehicle productivity has once more approached five passengers per vehicle-hour. Origin-destination analysis during both 1975 and 1976 has disclosed that the average passenger trip length (auto driving distance) is approximately 2.8 miles. This results in a passenger-mile per vehicle-hour figure of 14.

As a result of the above productivity trends, DAB operating cost per passenger steadily decreased until it leveled off at around $3.00 during 1975. It then rose to approximately $4.50 per passenger in early 1976 as a result of the simultaneous increase in costs and decrease in ridership. On a passenger-mile basis, cost per passenger-mile was approximately $1.05 during 1975 and increased to $1.60 in early 1976. The real operating cost per DAB passenger is probably about $.25 higher than indicated because almost all control room costs should be allocated to DAB rather than distributed over the entire number of PERT vehicle-hours.

Work and feeder subscription productivities and unit costs have varied considerably over the project's life. During the 1973-74 winter, vehicle productivity surpassed ten passengers per vehicle-hour for a three-month period. Since then, vehicle productivity has generally been around six, increasing during the fall and winter and decreasing in spring and summer. Consequently, operating cost per passenger fell as low as $1.34 in March 1974 but has fluctuated within the $2-$3 range since then. These costs are high by about 15%, if it is assumed that only a negligible proportion of the control room effort is dedicated to subscription service.

Home-to-school subscription productivity was in the 15 to 20 passenger per vehicle-hour range during its first two years, but decreased to around 13 during the past school year. Consequently, cost per passenger has recently risen from the earlier levels of under $1.00.

PERT senior citizen special services have the lowest per-passenger operating costs in the system as a result of having the highest vehicle productivities of any PERT service. Senior citizen per passenger costs have consistently remained below $1.00. This service also has the greatest revenue recovery factor of about 45%; DAB has a recovery factor of less than 25%.

Selected Innovation Impacts (Greece)

Route Rationalization. Service on RTS fixed-routes 10 and 14 was eliminated in Greece during the offpeak periods when DAB operates. These changes occurred in June 1974 in the case of Route 14, and September 1974 and January 1975 in the case of Route 10. Ridership data for the fixed-routes prior to the changes is somewhat sketchy, but best estimates are that PERT captured between 25% and 35% of the former offpeak fixed-route riders. The other riders either used the fixed-route buses during the peak period or have changed their tripmaking pattern significantly by either foregoing trips or using alternative modes. The most important reasons for this loss of transit ridership are that most former fixed-route riders judged the fixed-route buses to be faster, more reliable, and more convenient than PERT with a transfer to fixed-route buses. Secondly, the fixed-route buses cost less than half of what DAB costs, although this cost difference was somewhat mitigated by a reduced midday feeder fare introduced in January 1975.

Approximately 28 daily vehicle-hours were saved as a result of eliminating Routes 10 and 14 during the offpeak period. While a greater number of DAB vehicle-hours were added between June 1974 and January 1975, most of these additional hours were required to meet the additional demand generated by service area (spatial) and time of day (temporal) expansions. While there was some overall reduction in costs, a conclusive statement regarding the specific cost savings as a result of route rationalization cannot be made. Furthermore, the loss in the number of passengers carried probably offsets the impact of whatever cost savings may have been realized.

Fare Changes. The only major fare change thus far has been a decrease in the cost of DAB for passengers transferring to and from fixed-route buses. Beginning January 6, 1975, passengers using DAB and transferring to or from a fixed-route bus paid only $.50 for their entire trip during the weekday 9:00 a.m. to 3:00 p.m. period, compared to $1.05 previously (a 52% reduction). The $1.05 fare remained during other periods of operation. This fare reduction occurred simultaneously with a Route 10 rationalization, so the impact was discerned only by examining the levels of transferring passengers from outside the Route 10 corridor. It has been found that the fare decrease served to increase the total number of daily PERT-RTS transfers by 38%.

Promotions and Marketing. Many marketing activities have been conducted by the PERT management, including several reduced-fare promotions. The latter efforts have included two general DAB half-fare weeks, two DAB half-fare coupon mailings to the entire service area, a widespread newspaper advertising campaign containing half-fare DAB coupons, three subscription service half-fare periods, and occasional distribution of half-fare coupons at the shopping malls. Some of these promotions--particulary the first DAB half-fare week and the newspaper campaign--resulted in significant ridership increases during the week of the promotions, as well as for several weeks following the promotion.

Vehicles. Beginning in the winter of 1975-76, severe vehicle breakdown problems were experienced. These breakdowns affected all of the various types of vehicles utilized by PERT. During this winter period, the vehicles were out of service on the average over a third of the time. Three or more on-the-road breakdowns daily was a common occurence. Almost all of the vehicles are based on recent designs, and consequently, design flaws are being encountered that may be rectified in future production runs.

Computerized Scheduling and Dispatching. Computerized passenger scheduling and vehicle dispatching were initiated in October 1975. Several problems arose during the phase-in of the computerized system ranging from software malfunctions, long computer response times, to a major fire in the contractor's computer center destroying several PDP-10 computers. When significant problems arose, system control was transferred from computer to manual control.

Results (Irondequoit)

During the first twelve weeks of Irondequoit service, ridership on the various PERT services remained fairly steady. Only DAB service underwent a growth stage, increasing from around 40 passengers per day to about 80; 15% to 20% of Irondequoit DAB passengers transfer at Dewey and Ridge to or from a Greece DAB. An average of forty persons per day used the loop shuttle during this 12-week period, while each subscription service generated a daily demand of about 25 passengers. Daily ridership on the Summerville Shuttle and Urban PERT has been about 150 and 260 per day, respectively. Few passengers on these two services have used the route deviation option; there are generally not more than two or three deviations per day on either serivce, and many days have experienced no deviation requests. Comprehensive evaluation work will begin after about five months of operation in the fall of 1976.

Assessment of Impacts

The variety of services and innovations in Rochester has resulted in a multitude of impacts which are difficult to disaggregate. PERT has dramatically increased the availability of transit to markets and areas served. Some of the special services--including those for the handicapped--have had a pronounced positive impact on the mobility of certain population groups. Average weekday ridership approached 800 during most of 1975, thus demonstrating the acceptance of PERT services by the community.

Some of the specific innovations, however, have been less successful. Indications are that route rationalization was not received favorably by transit users and whether actual cost savings were realized is unclear. The public has not yet taken full advantage of the route deviation option offered in some of the Irondequoit service. In these cases, however, there is no negative impact to the former fixed-route users as there was associated with route rationalization in Greece.

The high cost per passenger of PERT service has been one of the tradeoffs associated with the increase in transit coverage. It is possible that computerized scheduling and dispatching will enable DAB productivities to rise and thus lower unit costs.

The poor vehicle performance, which has been experienced since December 1975, has been a factor that has negatively affected PERT services and their impact on the community. DAB service was especially degraded. Approximately 20% of DAB ridership in Greece was lost during the past winter, and those passengers remaining were continually subjected to unforeseen delays. It may take considerable time to ameliorate the adverse impression of PERT in the minds of Greece residents before significant ridership gains can be achieved.

IMPLICATIONS

The Rochester demonstration provides several examples of transit services that can be provided in the suburban region of a major metropolitan area. Greece represents a case in which a low level of transit service previously existed, while in Irondequoit, PERT services supplemented a fairly comprehensive network of fixed-route buses. The PERT service areas resemble typical suburban areas with the possible exception of the heavy concentration of suburban employment in Kodak Park.

One specific phenomenon which may limit the applicability of the results is the vehicle breakdown problem since December 1975. Part of this is attributable to the severe weather conditions experienced in Rochester, which may not be present in other localities.

The stable conditions which existed during most of 1975 indicate that a (relative) system-steady state had been achieved in Greece. DAB ridership, productivity, and service quality tended to be fairly uniform during this period and represent the levels which were achieved after an intensive year and one-half of service changes and promotions. The results suggest that DAB will have only a modest impact on total local travel in a suburban area. DAB ridership, as a percentage of all trips made, is very small (under 1%) and is smaller than that previously carried by the three fixed-route buses during the offpeak period. Including the peak period, these three fixed-route buses continue to carry more area riders than PERT.

The flexibility of PERT services, however, has served specific groups well in Rochester. The elderly and handicapped have been clearly shown to benefit from the doorstep service provided, as well as from the various special transit services. Many dial-a-bus users indicated that they could not have made their trip without PERT.

Subscription users, on the other hand, are predominantly "choice" riders, with many of them preferring PERT over the regular RTS buses and reporting that they would drive if PERT were not available.

The implications of PERT are thus numerous. The variety of services being offered and the great number of innovations which were implemented confound the evaluation process. Evaluation of the demonstration is proceeding with the intent of disaggregating, where feasible, the individual impacts so that other localities may selectively utilize the various concepts which are being experimented with in Rochester.

REFERENCES

1. Massachusetts Institute of Technology, PERT: The First Year of Operation, December 1974.

2. SYSTAN, Inc., Evaluation Plan for the Rochester Integrated Transit Demonstration, October 1975.

APPENDIX E

INTEGRATED DIAL-A-RIDE AND FIXED ROUTE TRANSIT IN ANN ARBOR, MICHIGAN

PROJECT OVERVIEW

Since the conclusion of a dial-a-ride pilot project in the fall of 1972, the Ann Arbor Transportation Authority (AATA) has developed and substantially implemented an integrated dial-a-ride and conventional fixed-route bus transit system (Teltran), utilizing a computer assisted reservation system, which provides the city with 100% geographic coverage during all hours of operation. The final phase of the Teltran system was implemented during the early summer of 1976. In addition, the AATA operates a many-to-many dial-a-ride service for the handicapped, a school subscription service, a number of bus routes in Ypsilanti, and service for the elderly and handicapped in rural areas of the country.

While neither the Teltran system nor the other transit services provided by the AATA are part of the Urban Mass Transportation Administration's (UMTA) Service and Methods Demonstration (SMD) Program, UMTA decided to conduct an evaluation of transit in Ann Arbor under the aegis of the SMD program. The decision to include an assessment of transit in Ann Arbor within the SMD program reflected the continuing national attention being given to this innovative transit system. The Teltran system has received substantial local financial support and has been responsible for dramatic increases in transit ridership. Thus, the Ann Arbor experience is both noteworthy and potentially useful to other areas considering major transit innovations in general and particularly integrated fixed-route bus and dial-a-ride service.

PROJECT OBJECTIVES AND EVALUATION ISSUES

The five Service and Methods Demonstration Program objectives:

1) Reducing travel time for users;

2) Increasing transit coverage;

3) Improving transit reliability;

4) Increasing transit vehicle productivity; and

5) Improving service to the transit dependent.

While each of these objectives directly apply to the Ann Arbor transit system, Teltran was implemented to meet two specific local objectives:

1) Providing 100% geographic coverage by transit, and

2) Reducing auto ownership to one car per family and maintaining it at that level.

Provision of 100% geographic coverage has strong implications for the level of service that can be provided in terms of travel times and reliability and the productivities that can be achieved. Although the evaluation is being conducted primarily with existing data and is constrained to a certain extent as a result, the evaluation will focus on describing the development and operation of the integrated fixed-route bus and dial-a-ride service and to the extent possible, the level of service provided by a system designed for 100% coverage. Other aspects of the project that will be examined are:

1) the shift in type of service and system configuration by time of day and day of week;

2) service provided to the transit dependent; and

3) institutional and operational issues involved in implementing integrated services, including

4) the effectiveness of an incremental implementation strategy.

PROJECT DESCRIPTION

Ann Arbor, site of the main campus of the University of Michigan, is a city of 106,000 with an area of 23.5 square miles (implying an average density of 4510 persons per square mile) located just outside the Detroit Metropolitan Area. The Ann Arbor Transportation Authority operates an integrated dial-a-ride and conventional fixed-route bus system which provides 100% transit coverage within the city during all hours of operation. The Teltran system employs dial-a-ride service within specific geographic zones (the number of which varies by time period) and connects the zones with fixed routes serving the downtown area and other

major activity centers. Passengers pay a 25¢ fare upon boarding either type of vehicle and all transfers are free. Thus, a rider may be picked up at his door by a dial-a-ride vehicle, transfer to a fixed-route bus for a trip downtown, and thereafter may transfer there to another vehicle for doorstep delivery, if necessary. Special half-price fares are available to low income, handicapped and elderly citizens; reduced price monthly passes are available to the general public. Transfers between dial-a-ride vans and fixed-route buses are coordinated to minimize wait time. Dial-a-ride vehicles perform flexibly-routed tours, with prescheduled arrival times at one or two fixed points within the zone. One or both of these locations, usually situated at existing centers of activity, serve as a transfer point to a fixed route. The dial-a-ride vehicle is scheduled to arrive at the transfer point shortly before the fixed-route bus, but if either vehicle is behind schedule, dispatchers can coordinate by delaying departures from the transfer point. Once passengers transfer between the vehicles, the dial-a-ride van begins its next tour. The driver determines the route for dropping off those who have just boarded and picking up those who have telephoned in requests for service, and eventually returns to the transfer point to meet another fixed-route bus.

Since fixed-route bus headways during peak periods are 15 minutes, several dial-a-ride vans must operate in each zone to permit coordinated transfers with each fixed-route bus. The city is presently divided into 14 zones for weekday service, 7 zones for weekday evening service, and 9 zones on weekends. Four (4) fixed routes are operated and serve the 7 dial-a-ride transfer points (see Figures E-1, E-2, and E-3).

Teltran also includes school subscription service for groups of 20 or more students traveling to the same school and living within 1.5 miles of their school, and a city-wide dial-a-ride service for the handicapped using special vans equipped with wheelchair lifts. Presently, the wheelchair market is fully served within the city and service is being extended to other areas within the county. In the future, the eligibility requirements for the city-wide service may be relaxed. Five (5) fixed-route bus lines in neighboring Ypsilanti are also operated by AATA.

A computer assisted system allows three dispatchers to handle the AATA fleet of 32 full-size transit buses and 48 dial-a-ride vans. In addition, a varying number of call takers answer questions and log in telephoned requests for service. Riders may telephone to request immediate or

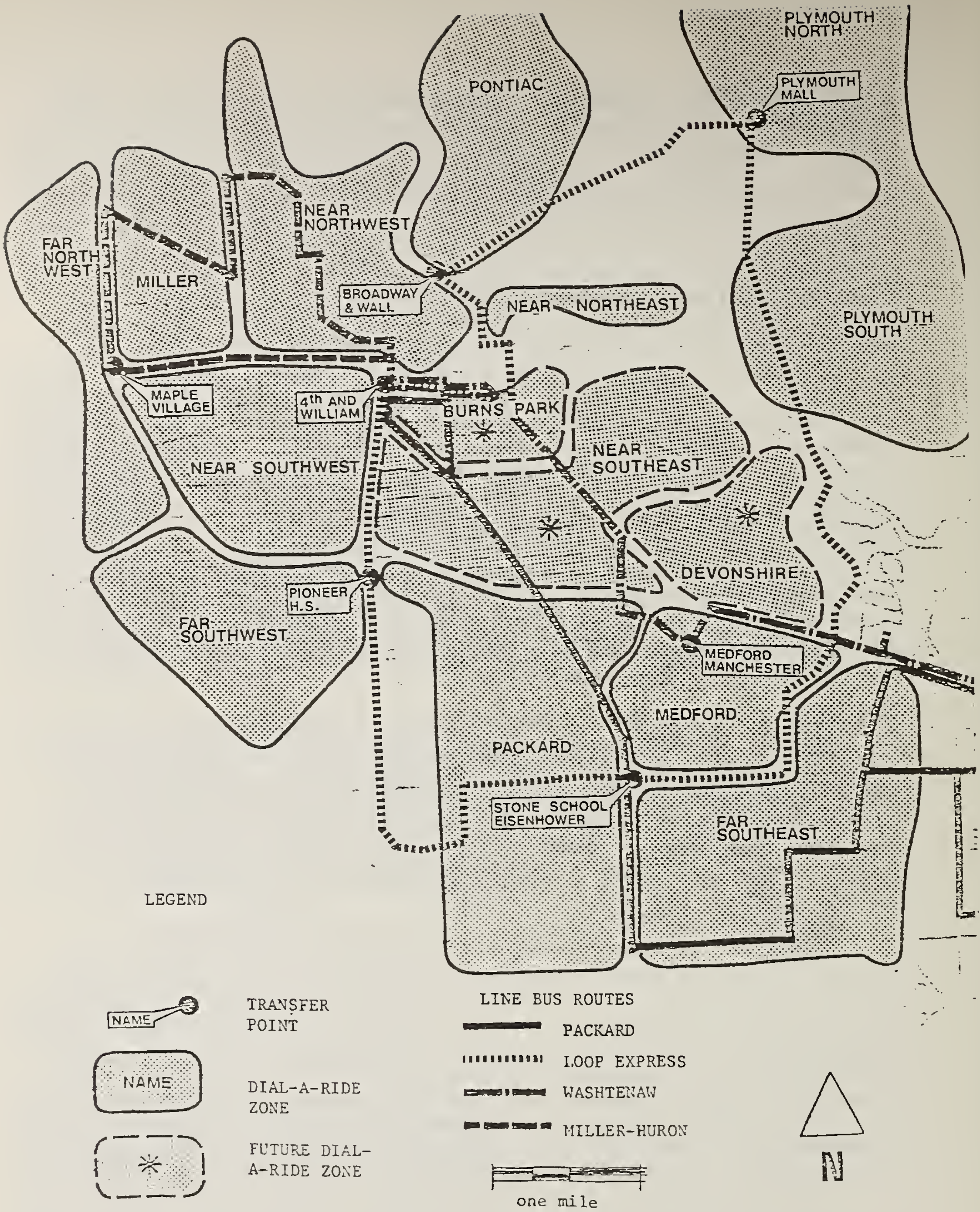
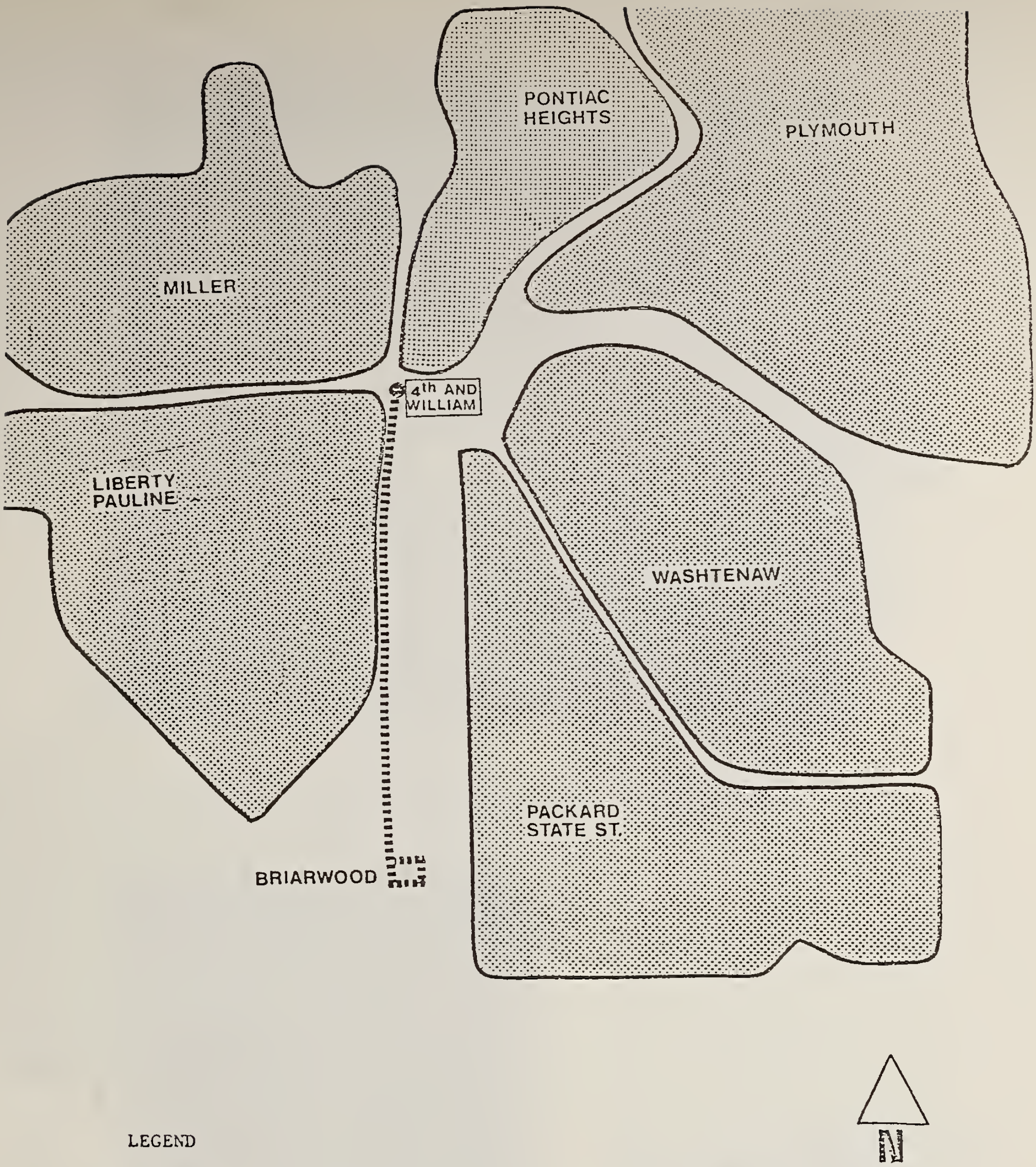


FIGURE E-1. WEEKDAY TELTRAN SYSTEM, ANN ARBOR



LEGEND

DIAL-A-RIDE ZONE

one mile

DOWNTOWN-BRIARWOOD ROUTE DEVIATION SERVICE

FIGURE E-2. CITY-WIDE EVENING TELTRAN SYSTEM, ANN ARBOR

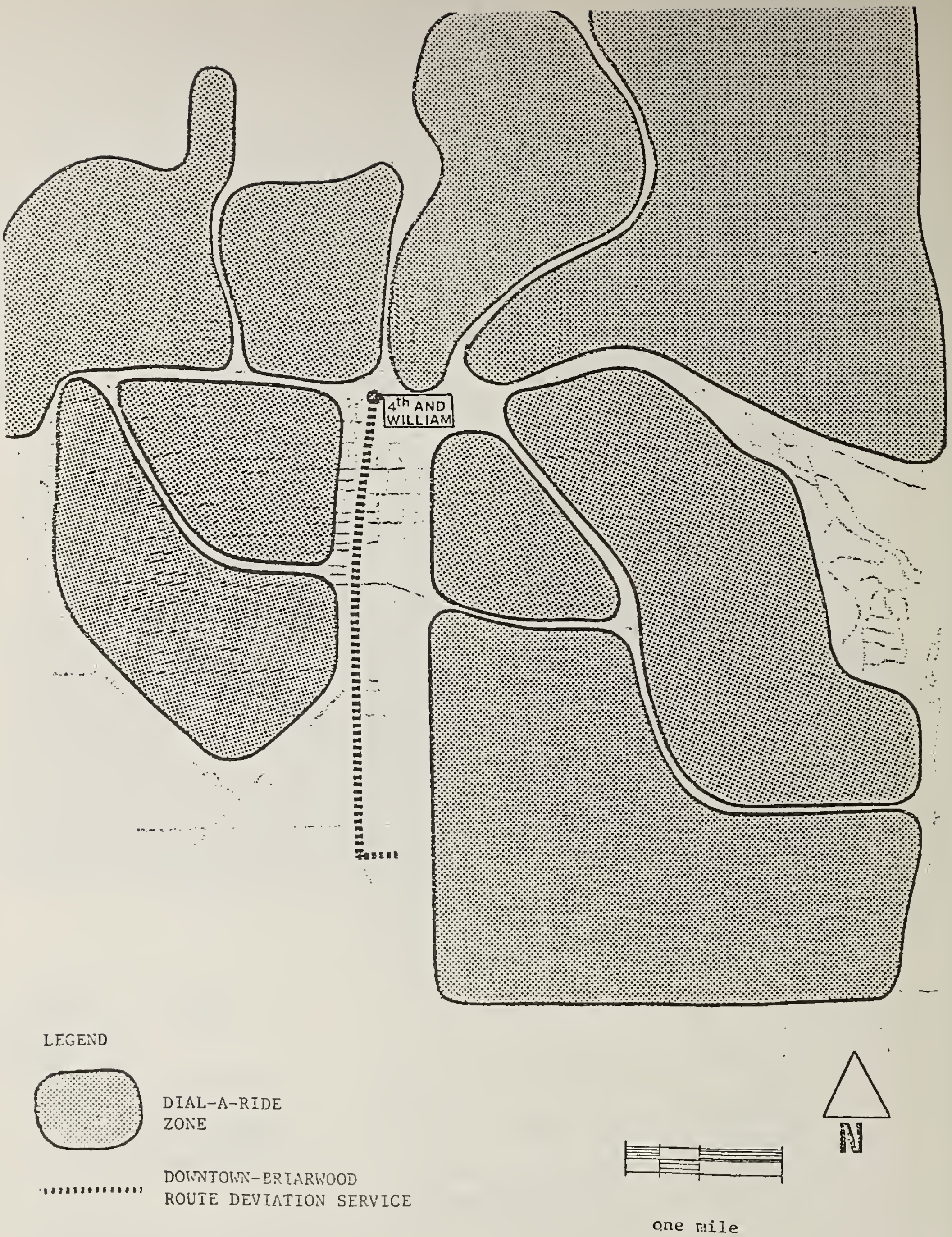


FIGURE E-3. WEEKEND SERVICE, TELTRAN SYSTEM, ANN ARBOR

Special Vans for the Handicapped Have Hydraulic Lifts, Ann Arbor, Michigan

Free Telephone Service for Teltran is spotted at several downtown Ann Arbor locations.

future pickups or place a "standing order" to reserve the same trip on a subscription basis. The computer acts primarily as a bookkeeper, keeping track of reservations, displaying them to call takers and dispatchers, and facilitating editing. The assignment of individual service requests to particular zones and vehicle tours is performed manually. While dispatchers currently radio tour lists to individual drivers manually, in the future, tour lists will be transmitted directly to display screens to be installed in each vehicle. However, there are no plans to automate the decision-making roles of the call takers or dispatchers within the foreseeable future.

PROJECT HISTORY AND STATUS

In July of 1968, after the last in a succession of private bus companies had ceased operations, the Ann Arbor Transportation Authority was created to serve the City of Ann Arbor, and the area in Washtenaw County within 10 miles of the city limits. Initially, service was provided through a short-term operating contract with a private firm. Subsequently, service was expanded as the AATA acquired its own vehicles and operated a fixed-route system which was carrying 540,000 passengers by 1972.

In April 1968, a citizens' committee met with representatives of Ford Motor Company to explore the feasibility of dial-a-ride service in Ann Arbor. About two years later the city directed Ford to develop a plan for implementing demand-responsive service and in November, 1970, a proposal for demonstration funding of a pilot project was submitted to the State of Michigan. The project, which operated from September 1971 to September 1972, offered primarily many-to-few service from a residential zone in the southwest portion of the city to the downtown, a shopping center, and the University. The service area at the conclusion of the project, after several expansions due to lower ridership than anticipated, was 2.4 square miles.

By the end of the project, dial-a-ride ridership had reached over 200 passengers per day and the AATA was very encouraged. Overall transit ridership originating in the zone had doubled and onboard surveys indicated that dial-a-ride service was appealing to a market not reached by regular fixed-route bus service. These results convinced the AATA that demand-responsive transit could play a significant role in Ann Arbor. The Teltran system was planned by the AATA in the fall of 1972 to provide

integrated fixed-route bus and demand-responsive service on a city-wide basis.

The first test of the Teltran plan came in April 1973 when the voters were asked to support it by approving a 2.5 mil increase in the property tax. The public passed the legislation with 61% of the vote and in the summer of 1973 implementation began. AATA chose a phased implementation strategy to facilitate the fine tuning of system operation and design as experience was gained and to permit adequate time to develop the staff necessary for full scale operation. By the end of the year, the AATA was providing service to the handicapped using a vehicle equipped with a wheelchair lift, and providing weekend and evening dial-a-ride service throughout the city. In 1974, Ypsilanti fixed-route service (connecting to Ann Arbor) and integrated dial-a-ride/fixed-route bus service on Saturdays was initiated. During 1975 service expanded considerably with all but three of the weekday dial-a-ride zones in operation. As of June 1976, all zones had received integrated service, and annual ridership is estimated at 1.8 million for the 1975-1976 fiscal year.

FINDINGS

By virtue of its design, Teltran achieved the local objective of 100% geographic coverage when the last remaining dial-a-ride zone was put into service. The other local objective, reducing auto ownership to one car per family, is essentially a long-range goal and there is insufficient data available at present to determine anything about Teltran's success in achieving this objective.

The lack of comprehensive pre-Teltran data made any real before/after analysis of the system's achievement of the five Service and Methods Demonstration Program objectives infeasibile. Instead, the evaluation's emphasis was on characterizing the present status of Teltran with respect to service objectives.

Travel time for an integrated, demand-responsive system may consist of many components including:

- time associated with phoning in a request for service;
- time spent waiting for a vehicle to arrive;

- in-vehicle time(s) (possibly more than one vehicle);
- transfer time(s); and
- walk time(s) at origin and/or destination.

The evaluation focused primarily on the dial-a-ride and coordinated transfer related portions of a Teltran trip, since these are the unique aspects of the system.

Whereas telephone associated delays had earlier been a problem, major difficulties appear to have been overcome. Currently, ninety-five (95) percent of all calls are answered within three minutes (mean time is 1.12 minutes) and processed (i.e., a reservation is completed) within 2.5 minutes (although this time varies greatly with the type of trip being requested).

For those callers requesting immediate service, the mean elapsed time (after completion of the phone call) before the vehicle arrived was 22.9 minutes (with a standard deviation of 12.5 minutes). Interestingly, riders perceived a significantly shorter wait time, perhaps because they could use the time effectively. Typically, the caller is provided with an estimated time of arrival (ETA) for the vehicle, usually a "window" of 10 to 15 minutes. Of those customers surveyed, 59% reported that their vehicle arrived "on time" (i.e., within the perceived window).

Dial-a-ride in-vehicle time for daytime trips was found to average 9.5 minutes with a standard deviation of 6.6 minutes. Average dial-a-ride trip length was 2.3 miles (with a standard deviation of 1.3 miles), implying an effective speed (including stops) of 14.6 miles per hour. During evening hours, when the service area is divided into fewer but larger zones, average trip length increased and in-vehicle time was 14.3 minutes.

Coordinated transfers from dial-a-ride vans to line buses or other vans averaged only 4.1 minutes for non-standing-order trips, with 36% of the riders having no wait at all (i.e., the second vehicle was waiting when the first van arrived). Transfer times from standing-order customers, which dominate a.m. peak period travel, averaged 5.4 minutes.

Since 1971, when the first innovations took place, total transit ridership in Ann Arbor has increased from 540,000 to the present 1.8 million for fiscal year 1975-

1976. About 4,000 trips were served by the special service to the handicapped.

During March 1976, the productivities, including transfer passengers, were 35.2 passengers per vehicle hour for line buses and 6 per vehicle hour for dial-a-ride. For all services, the estimated total annual productivity for fiscal year 1976 is, on a first fare basis, 10.5 passengers per vehicle hour. Estimates of annual operating costs per vehicle hour and vehicle mile for the entire system for fiscal year 1976 are $19.85 and $1.58, respectively. Of the total operating costs, 78% were due to wages and fringe benefits (including management and administration), 8% were due to vehicle operating costs, with the remainder due to fixed costs of which the largest elements were due to planning and fleet insurance.

The operating cost per passenger is $1.89. Including transfer passengers, the cost per passenger is $0.56 for line bus and $3.31 for dial-a-ride. The deficit per passenger is $1.66 of which $0.93 is covered by the millage tax. The rest of the deficit has been funded primarily by both federal and state operating assistance grants.

Transferability

While it is too early to judge the long term impact of the Teltran system, there are some unique characteristics of Ann Arbor which have contributed to its success to date. Ann Arbor is a university town which has had a reputation for being in the forefront of the environmental movement and which supports public transit through a dedicated property tax millage. The local objective of 100% coverage reflects a widely held concern for providing public transportation for all citizens. Thus both the ridership and financial support given to Teltran may in part be attributed to the unique nature of Ann Arbor. However, since the University of Michigan operates its own internal transit system free of charge, much of Teltran's ridership and public support does come from individuals with no direct connection to the University. Thus given a suitable site and proper planning, a system like Teltran might have similar success elsewhere if strong local support can be generated and funding mechanisms found.

APPENDIX F

XENIA MODEL TRANSIT SERVICE DEMONSTRATION PROJECT

OVERVIEW

The Xenia, Ohio, Model Transit Service Demonstration Project (OH-06-0022) has involved the provision of both fixed-route and paratransit services in a community that was partially destroyed by a tornado. The project began July 22, 1974, when a one-year Service and Methods Demonstration project grant was awarded to allow continued operation of a fixed-route transit service implemented April 6, 1974 with funds from the Federal Disaster Assistance Administration. Service and Methods funding, along with a capital grant, allowed the City to establish a transit department, purchase vehicles, and operate the transit service known as the X-line.

During the demonstration period the City obtained an eighteen month extension to the project to allow the implementation of paratransit services. The termination of the project has since been extended to December 31, 1977. Currently, paratransit services only are provided: the local taxi company, under contract to the City, operates both exclusive-ride and shared-ride taxi (dial-a-ride) services, using 7-passenger automobile-type vehicles. An advanced request dial-a-ride service for the handicapped, using a lift-equipped minibus is also provided, as is a pre-arranged group trip service and subscription service. Both of these services use either automobile-type vehicles or larger minibuses, depending upon group size. The overall fare structure is scheduled to be changed on January 1, 1977, to make fares more representative of costs incurred.

Funding

Funding for the project has come from the sources shown in Table F-1. Thus far a total of $1,399,739 has been committed to the project from Federal, State, and local sources.

OBJECTIVES AND EVALUATION ISSUES

The Xenia Demonstration addresses the following SMD objectives:

1. Increase transit coverage;

TABLE F-1

XENIA SMD PROJECT FUNDING

Source	Amount	Dates	Purpose
UMTA			
SMD-Section 6	$300,000	7/74-7/75	Demonstration Phase 1 Operate fixed-route service
SMD-Section 6	355,000	7/75-12/77	Demonstration Phase 2 Operate paratransit service Purchase vehicles
Section 3	272,282	FY75	Capital Grant - Demonstration Phase 1
Section 5	68,032	7/75-12/75	Support fixed-route service
Other Federal			
FDAA	$184,182	4/74-7/74	Operate fare-free emergency service
Manpower	160,000*	7/74-12/77	Support demonstration
State	$ 10,000	3/74-3/75	Elderly half-fare subsidy
Local	$ 68,243	FY75	Capital grant in-kind
TOTAL	$1,399,739	-	-

*Estimate - exact figures not available.

2. Increase transit productivity;

3. Increase reliability;

4. Improve service to transit dependent; and

5. Decrease travel time.

Major local objectives are:

1. Demonstrate the technical, operational and economic feasibility of paratransit service in a small city, and

2. Determine an appropriate role for the private sector in the operation of public transportation services.

Key Issues to be Examined

The innovations in the Xenia demonstration have introduced a range of issues that can be addressed in the course of the evaluation. Key issues are:

1. How do the operating characteristics of the paratransit services implemented in the course of the demonstration compare with the characteristics of fixed-route service?

2. How do the passengers view the trade-offs between level of service and cost in the service options available concurrently?

3. How does public and private operation of transit service in Xenia compare from a cost-effectiveness standpoint?

4. How do the mechanics of the taxi company/City contract impact the operator, the drivers, and the City?

5. How do the bus-type and automobile-type vehicles used in Xenia compare in terms of cost and reliability, and what are the attitudes of drivers and passengers towards the vehicles?

6. How has the availability of transit in Xenia impacted auto ownership and travel patterns?

Flexicabs Providing Paratransit Service,
Xenia, Ohio

PROJECT DESCRIPTION

Services and Innovations

Phase 1 of the Xenia demonstration was less a test of innovative service concepts than a test of conventional service concepts in a unique setting. Fixed-route transit service was implemented in Xenia to assist community residents during the redevelopment period, subsequent to a natural disaster which did extensive damage to the city.

New or innovative service conepts that were introduced during Phase 1 of the demonstration were:

1. An advanced request dial-a-ride service for the handicapped;

2. A prepaid pass scheme; and

3. Sunday and holiday dial-a-ride service (replacing the fixed-routes).

Phase 2 of the demonstration has involved the introduction of a number of new or innovative ideas including the following:

1. The operation of a mix of paratransit service levels with a variable pricing structure.

2. The provision of paratransit services as the only transit services in the City.

3. The provision of all paratransit services, including exclusive-ride taxi service, by a private operator under contract to the city.

4. The use of automobile-type vehicles (nicknamed Flexicabs) to provide the paratransit services.

The service levels to be offered during Phase 2 of the demonstration, the fares, the method of computation, and the vehicles to be used for each service are shown in Table F-2.

Site Characteristics

Xenia, Ohio (see Figure F-1), is a city of nine square miles and, according to a 1976 census estimate, has almost 28,000 population. It lies 15 miles outside the Dayton, Ohio, boundary. Xenia is essentially a middle income

FIGURE F-1. CITY OF XENIA

FIGURE F-2. FINAL XENIA FIXED ROUTE SYSTEM

community, composed largely of single family homes. The City is not a self-contained community, despite the fact that it does not border upon any other developed area. Over 50% of Xenia residents work outside the Xenia area, primarily in Dayton and at the Wright Patterson Air Force Base. Employment within Xenia is largely service or public administration related. Three institutions of higher learning, Wilberforce University, Central State University, and the Payne Theological Seminary also serve as work destinations for Xenia residents. Commuting outside Xenia is not limited to the work trip; it has been estimated that 50-60% of the people in Xenia shop outside the city limits.

The population of Xenia is fairly young, as demonstrated by the median age which, according to the 1970 census, was 24.7, compared to the national average of 27. According to recent figures, Xenia residents over the age of 65 comprise only 5% of the total population, which is only half of the national average.

The tornado that hit Xenia on April 3, 1974, had a devastating impact. It was estimated that as many as 39% of all homes, 52% of all businesses, and 60% of all automobiles and school buses were destroyed or damaged by the tornado. A total of 1,250 housing units were destroyed or subsequently condemned. Over 2,150 persons were put temporarily out of work, while 1,250 persons, 32.6% of the local job market, permanently lost their jobs. Six schools, including the high school and two junior high schools were destroyed. The tax base was reduced from $83 million to $55 million.

Redevelopment has proceeded, but is far from complete. Approximately 75% of the single family homes that were destroyed have been rebuilt. The population, which had decreased from 28,500 in 1974 to under 27,000 is now estimated to be about 28,000. The largest employer in the area has permanently closed, but other businesses have rebuilt. Unemployment in Xenia is estimated to be 8%, above Green County figure of 5.9%, but below the State average of 8.5%. The tax base has increased to $87 million during the redevelopment period.

HISTORY AND STATUS

After the tornado destroyed a sizeable portion of the City of Xenia, city officials recognized that some form of public transportation service would be needed during the reconstruction. They enlisted the aid of the Transportation

Coordinating Committee (TCC), the transportation planning arm of the Montgomery-Greene County Planning and Development Commission, in planning a new transit system. The City applied for and received a grant from the Federal Disaster Assistance Administration (FDAA) to operate a fare-free, fixed-route bus service. Just 62 hours after the tornado, bus service began in Xenia, operated under contract by the Miami-Valley Regional Transportation Authority. The service consisted of a set of four fixed-routes operating with seven vehicles on 30-minute headways. In addition, commuter service was initiated between Xenia and major employment centers in Dayton and the neighboring communities of Fairborn and Springfield. The special commuter services were discontinued after one week as a result of limited patronage, but the intra-city service was continued.

The TCC and the City recognized that transit service would be needed in the community after FDAA funds ran out. While the TCC was developing a transit plan for Xenia, City officials began preparing a demonstration application for funding under the UMTA Service and Methods Demonstration Program. A formal application was submitted to UMTA on June 3, 1974, and approval was granted on July 21, 1974.

No changes were made to the service when SMD funding began on July 22, 1974. During the following weeks, the City established a Transportation Department, hired drivers, and leased ten 19-passenger Flxette buses.[1]

On September 1, 1974, City personnel began operating the system now known as the X-line. The basic route structure remained unchanged, but a \$.25 fare was introduced.

During the first year of the demonstration project, the route structure was revised on two occasions, and the fare structure modified substantially.[2] Major innovations during

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[1]The vehicles were purchased with the help of an UMTA capital grant in March 1976.

[2]The route structure was revised in November 1974 and again in July 1975. The \$.25 base fare was augmented by a \$.10 fare for students, half-fare for the elderly, \$.50 fare for the handicapped service, \$.10 Sunday and holiday fare for everybody, and a \$10.00 monthly pass good for unlimited travel (\$4.25 for students). In addition, a merchant fare reimbursement program was introduced, whereby merchants would purchase and distribute \$.05 tokens to customers for use on the X-line. The final fixed-route configuration is shown in Figure F-2.

X-Line Bus Used in Fixed-Route and Later in Charter (Paratransit) Service, Xenia, Ohio

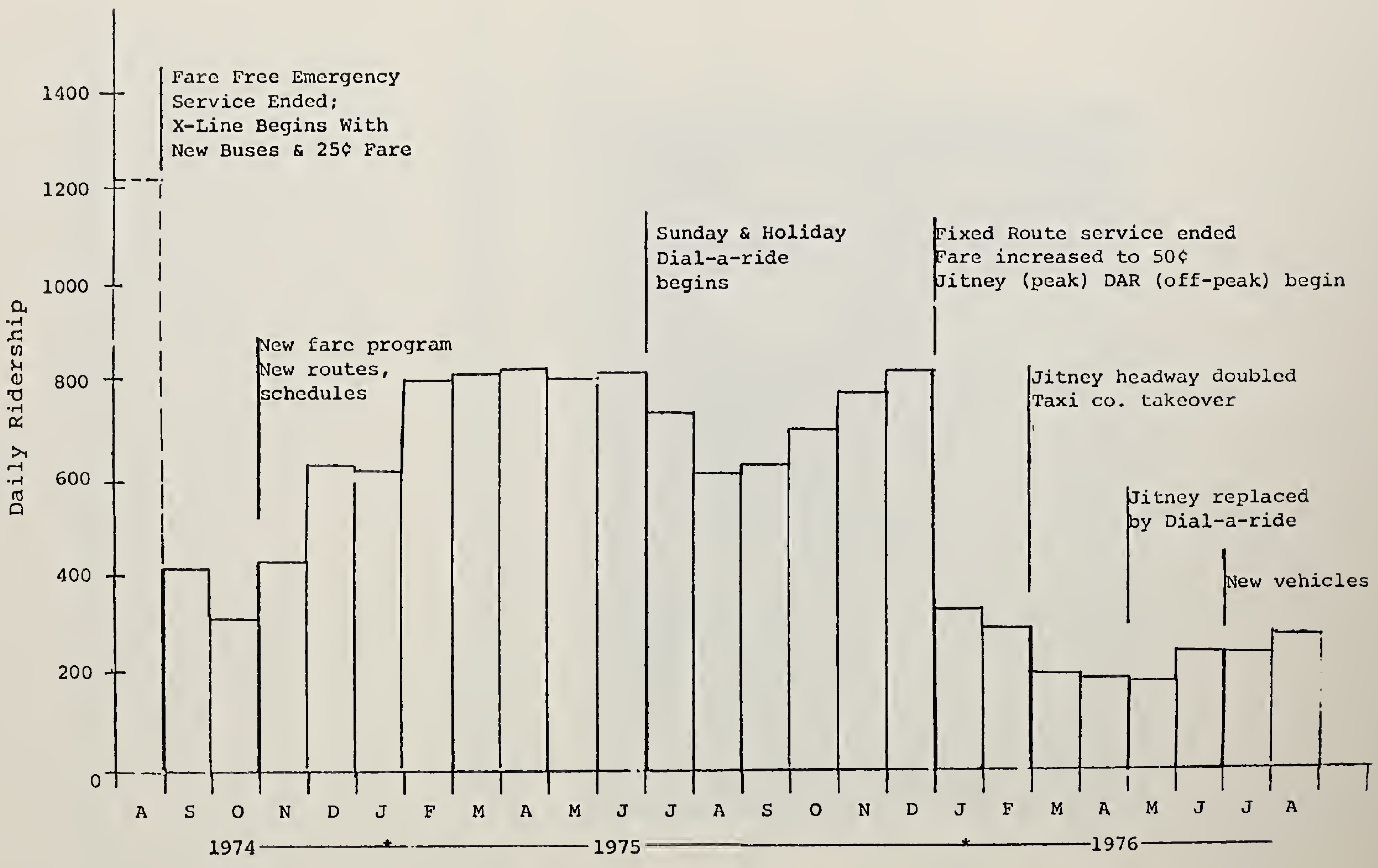

FIGURE F-3. AVERAGE DAILY RIDERSHIP BY MONTH

this period were the introduction of an advance request dial-a-ride service for the handicapped in November 1974, and the replacement of fixed-route service on Sundays and holidays with dial-a-ride service. The latter service began on July 4, 1975.

The planning conducted during the first year of the demonstration served as the basis for an application to UMTA for an 18-month extension to the demonstration. Additional SMD funding was requested (in a grant application submitted on April 10, 1975) for the purchase of seven 7-passenger vehicles to be used to provide dial-a-ride and other paratransit services to complement the fixed-route system. Under these plans the City would continue to operate the fixed-route service, using its own resources plus UMTA Section 5 operating assistance funds.[3] The local taxi company would operate the paratransit services under contract to the city.

The project extension was approved and scheduled to begin on July 22, 1975. Local concerns over the city's ability to continue to support the fixed-route system after December 1, 1975, delayed the start of any new services. In November 1975, Xenia residents voted down a proposed tax measure designed to support X-line services; subsequently, the city council voted to discontinue the service at the end of the year. As a result, the city began negotiating with UMTA for changes in the demonstration that would enable the city to maintain a continuous operating transit system. Agreement was reached to test the feasibility of serving the entire community with paratransit services to be operated by a private operator.

The paratransit services that constitute Phase 2 of the Xenia demonstration have been implemented in a series of steps. On January 1, 1976 fixed-route/fixed schedule service was replaced with unscheduled jitney service during peak hours, and with dial-a-ride service during offpeak

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[3]Dayton extended its Urban Boundary to include Xenia and, consequently, Xenia (pop. 28,000) became eligible for Section 5 funds.

hours. All fares were increased to $.50 at this time, with senior citizens retaining half-fare privileges on the jitney service. The city continued to operate the service until March 1, 1976, when the Xenia Taxi Company entered into contract with the City to operate the service.*

Service changes instituted by the taxi company included a doubling of the base jitney headway to one hour, and the extension of dial-a-ride service hours until 10 p.m. The taxi company also provided dial-a-ride service during peak hours for persons who could not use the jitney service. In addition, a pre-arranged group trip service was started. Because of legal complications associated with the change in operators, half-fare for the elderly was eliminated when the taxi company began operating, but was reinstated, for jitney service only, on April 1, 1976.

The next major service change came on May 9, 1976, when jitney service was eliminated, and dial-a-ride service instituted throughout the (service) day. During the week of July 4, 1976, 7-passenger Checker vehicles were phased into service, replacing the Flxettes and the regular taxicab that had been in use up to that time. The new vehicles have been dubbed Flexicabs. The Flxettes were retained to serve as a back-up, to be used for group service, and to be used for subscription service, which began on September 6, 1976. The final service change presently planned for Phase 2 of the demonstration is a revision of the fare structure, increasing the dial-a-ride fare from $.50 to $1.00. Passengers who request service at least 2 hours in advance will be charged $.75 during peak hours, and $.50 during offpeak hours. The fare structure is scheduled to be revised on January 1, 1977.

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*The contract between the city and the taxi company called for revenue to be divided in the following manner: 60% goes to the drivers; 30% to the city; and 10% to the operator as a management incentive. The city's share is applied to the payment of operating costs (which are the city's responsibility). During the early months under this arrangement when ridership, and hence driver earnings, were low, drivers were paid $.20 per passenger up to 8 per hour plus 60% of total revenue.

PRELIMINARY FINDINGS

The formal evaluation of the Xenia demonstration is just beginning; for this reason detailed results are not yet available. However, some preliminary findings can be reported. The period of fixed-route service, September 1, 1974 to December 31, 1975, will be considered first. Average daily ridership, on a monthly basis is shown in Figure F-3. When it was announced that service would shortly be stopped in June 1974, ridership dropped to 1,200 passengers per day from an earlier level of 2,000 passengers per day. The initiation of the $.25 fare on September 1, 1974, caused a dramatic ridership decrease to 400 passengers per day. Both of these early ridership decreases can probably be traced in part to the rebuilding process. It can be assumed that the need for public transportation decreased in a segment of the population as they rebuilt homes and repurchased automobiles. The extent to which the threat to halt service caused persons who would otherwise have continued to use transit to purchase an automobile cannot be determined.

Subsequent improvements to the route structure, reductions in the student and Sunday and holiday fare structure, the initiation of a marketing program, and the onset of winter weather all had positive impacts on ridership. By February 1975, ridership had doubled to 800 passengers per day and remained at this level through June. Ridership declined during the summer months, but climbed again to 840 per day by December 1975.

Monthly operating costs and deficits are summarized in Figure F-4. Variations in cost from month to month are largely the result of the cash flow accounting method used in Xenia rather than actual cost differences. The deficit appears to have decreased somewhat during the period of fixed-route service, but the impact of higher ridership on net cost was in part offset by the impact of reduced fares for students and the elderly and handicapped.

The results of the three major innovations of the fixed-route phase of the demonstration can be summarized briefly:

1. <u>The introduction of advanced request dial-a-ride service for the handicapped</u>.

    - This service never attracted many passengers; aside from special group trips, ridership never averaged more than four per day. Reasons for this

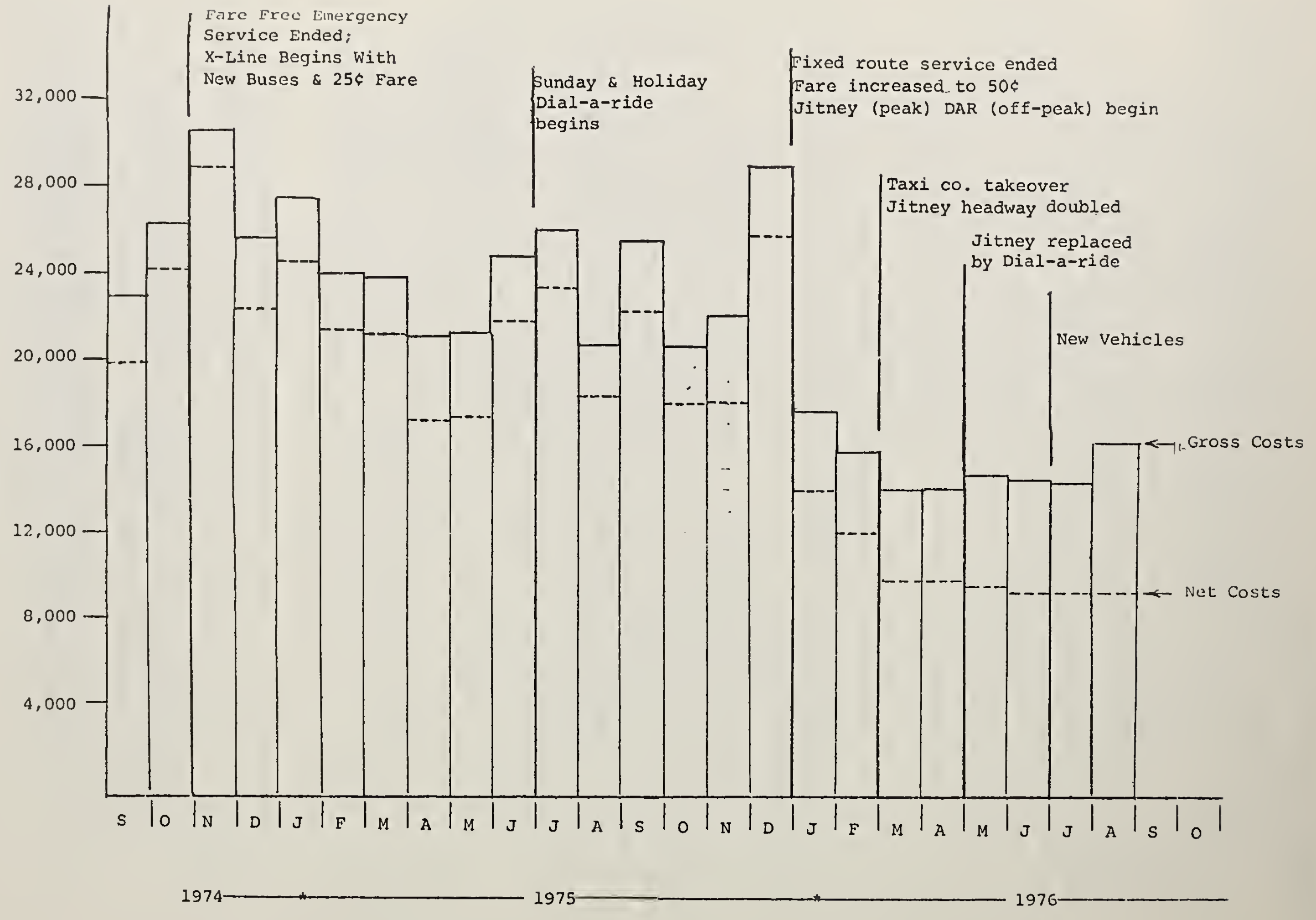

FIGURE F-4. MONTHLY OPERATING COST AND OPERATING DEFICIT

TABLE F-2. SERVICE LEVELS, FARES, AND VEHICLES - PHASE 2

Service Level	Fare	Vehicle	Fare Computation
1. Exclusive ride (taxi)	$1.00 1st 1/6 mile $.20 ea. addtnl. 1/3 mile or portion thereof, for 1st passenger. Flat 25¢ ea. addtnl. passenger same trip. 20¢/min. waiting time	Flexicab	Taximeter
2. Shared ride, less than 2 hours notice	$1.00 per passenger	Flexicab	Driver/Dispatcher
3. Peak shared ride, more than 2 hours notice	$.75 per passenger	Flexicab	Driver/Dispatcher
4. Off-peak, shared ride, more than 2 hours notice	$.50 per passenger	Flexicab	Driver/Dispatcher or tickets
5. Commuter service, pre-arranged group, paid in advance	Variable according to group size and distance traveled (negotiated rate)	Flexicab or Flxette	Negotiated, then tickets or passes
6. Pre-arranged group, out-of-city	$1.00 per 1-way mile (includes return trip) + $6/hr. waiting time	Flexicab or Flxette	Prepaid, return trip coupon

result include: (1) the $.50 one-way fare; (2) limited marketing; and, (3) unreliable equipment which resulted in missed runs. (The wheelchair equipped vehicle was frequently needed to replace the regular vehicles on the fixed-route system.) No market research was undertaken to determine what the actual market for the service might be.

2. <u>The introduction of a pre-paid monthly pass for unlimited riding</u>.

   - Passes were slightly more popular with students than adults; at one point, ridership of student passholders averaged about 7% of total student riders, while ridership by adult passholders never exceeded 4% of total adult ridership. The major reasons for the relatively small usage of passes was the cost: a $10 monthly pass offered savings only to adult passengers who used the service more than 40 times per month, and to students who used it more than 42 times. Thus very few persons stood to benefit from the pass.

3. <u>The introduction of Sunday and holiday dial-a-ride service</u>.

   - The replacement of fixed-route service with dial-a-ride service on Sundays and holidays did not appear to have significant impact on ridership. However, this change did result in a slight decrease in service miles and hence an increase in system productivity.

The shift from fixed-route to paratransit service and the accompanying fare increase on January 1, 1976, had an immediate impact on ridership. Average daily ridership fell to 350. The largest single cause of the ridership decrease was the fare change, since level of service was not dramatically altered. Other factors that played a role, however, were: (1) the perceived unreliability of the jitney service, which did not adhere to a strict schedule and (2) confusion stemming from the service changes and earlier announcements of pending service curtailment (following the November 1975 referendum).

Despite the ridership decrease, the operating deficit in January 1976 decreased 33% from the average of the previous four months. This was the direct result of both the fare increase and a reduced number of service hours. A

deficit decrease was a major objective behind the shift from fixed-route to paratransit service.

Following the taxi company takeover of the operation on March 1, 1976, and the accompanying doubling of the jitney headway to one hour, ridership again decreased significantly. The major factor in the ridership decline was the unreliability of the jitney service, which was due to a number of factors. First of all, the taxi company drivers were unfamiliar with the routes and, during the early weeks of service, occasionally did not keep to them. This problem was exacerbated by a rapid turnover of drivers, caused primarily by the low ridership. Drivers were paid on a commission basis; low ridership resulted in extremely low compensation. The lack of drivers caused a number of run cancellations, further decreasing the reliability. Finally, the one-hour headway played a major role. Since the vehicles were not following prescribed schedules, passengers who missed a bus were forced to wait one hour for the next bus, clearly an unacceptable wait time.[5]

As ridership on the jitney service decreased, continuation of the service became infeasible. Despite an earlier intention to retain the service structure until new vehicles were obtained, jitney service was replaced by dial-a-ride service on May 9, 1976. Although the long-term impact of this change is not yet known, in the short-term, the change seems to have had the desired effect. As people in the community began to perceive an increase in reliability, ridership began to grow. Ridership for the month of June 1976 was 36% higher than ridership during the month of April 1976. Results obtained in early August 1976 indicated that ridership was continuing to increase, despite the fact that August is traditionally the month of lowest transit ridership in Xenia.

The last significant service change that was made was the introduction of automobile-type vehicles in July 1976. Data on the impact of this change on operating cost and reliability are not yet available. However, both passengers and drivers were surveyed in August 1976 to determine their attitudes towards the automobile-type vehicles and the

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[5]Another factor that influenced ridership on the jitney service, was the fare structure. Since the offpeak dial-a-ride service offered a higher level of service at the same fare, some passengers shifted the time of their trip from peak to the offpeak.

minibus vehicles used in the service. The automobile-type vehicles were rated superior in all performance categories by both the drivers and the passengers. Preliminary results of these surveys are shown in Tables F-3 and F-4.

In Figure F-4, note that the change from public to private operation of the transit service did have the desired impact of decreasing operating costs. The major reasons for this decrease were a reduction in the number of service hours, and the change in driver compensation from salary to a commission basis.

To summarize some results of the entire demonstration to date, and to provide some indication of the impact of the shift to paratransit service, some key service indicators are shown in Table F-5. To help interpret this table, a number of notes are in order.

1. The fixed-route ridership figures exclude an average of 3,133 passengers per month who were either transfer passengers or other non-revenue passengers. Total fixed-route passenger productivity averaged 8.8 passengers per vehicle hour.

2. The low cost per hour figure for the two-month period of public operated paratransit service is low in part because virtually no maintenance was performed on the vehicles during this time period. However, the figure is deceptively low, because of the cash flow accounting system used. The actual cost for those months was probably fairly comparable to the cost during the previous year.

3. The six-month period of taxi company operation of the service is divided into the period when flexible route and jitney service was provided, and the period where flexible route service only has been provided. Note that <u>revenue and productivity</u> during this latter period <u>exceed</u> the levels during publicly operated paratransit, while <u>cost and deficit per passenger and per revenue hour are lower</u>.

4. Operating cost and deficit figures for the taxi company operation of DRT service are somewhat misleading, since at present the drivers are receiving virtually 100% of the revenues, while the operator is receiving 10% of the revenues plus a $1,250 per month management fee. As revenue

increases, driver compensation should return to the originally planned level of 60%. Thus the deficit should be expected to decrease.

It should be stressed that all of the figures presented in Table F-5 are preliminary, and will be refined as the evaluation proceeds. Phase 2 of the Xenia demonstration, paratransit service operated by a private taxi company under contract to the city, has been underway only a short time, and thus it is not possible to draw final conclusions. However, based on preliminary data, it appears that the shift to privately operated paratransit has had the desired effect of lowering the system cost and deficit. The most dramatic illustration of this is the service ratio, the ratio of cost to revenue, which has decreased from 8.0 to 2.7.

TABLE F-3

ATTITUDES OF PASSENGERS TOWARDS VEHICLES

Characteristic	Mean Rating: -2(very poor) Flxettes	to +2(very good) Checkers
Ease of Entry	.93	1.40
Noise	.27	1.30
Smoothness of Ride	.03	1.29
Seating Comfort	.67	1.31
Privacy	.43	1.04
Overall Comfort	.49	1.38

Response to Questions

In which vehicle would you prefer to ride?

Flxette - 11.2% Checkers - 81.0% No Preference - 7.8%

As a result of the introduction of the taxi vehicles, do you ride?

less often - 7.5% as often as before - 48.6% more often - 43.9%

TABLE F-4

ATTITUDES OF DRIVERS TOWARDS VEHICLES

Characteristic	Mean Rating: -2(very poor) to +2(very good) Flxettes	Checkers
Ease of Entry	1.00	1.50
Noise	-.29	1.63
Smoothness of Ride	-.50	1.38
Seating Comfort	.25	1.38
Privacy	.14	.50
Brakes	-.71	1.75
Visibility	1.14	1.63
Maneuverability	.71	1.75
Equipment Reliability	-.14	1.63
Overall comfort	.14	1.63

TABLE F-5

SERVICE INDICATORS

Indicator	Fixed-Route 9/1/74-12/31/75	Public Paratransit 1/1/76-2/28/76	Taxi-Operated Paratransit 3/1/76-5/31/76	Taxi-Operated Paratransit 6/1/76-8/31/76
Avg. Monthly Ridership	17,834[1]	9,719	6,238[2]	7,905[4]
Avg. Monthly Revenue	$ 3,083	$ 3,374	$ 3,746[3]	$ 5,250[5]
Avg. Monthly Cost[6] (Operating)	$24,713	$17,555	$13,467	$14,175
Service Ratio: cost/revenue	8.0	5.2	3.6	2.7
Ridership/veh-hr.	7.5	5.0	4.9	5.2
Cost/veh-hr.	$10.37	$9.33[6]	$10.52	$9.10
Deficit/veh-hr.	$ 9.08	$7.54	$ 7.59	$5.78
Cost/passenger	$ 1.39	$1.86	$2.16	$1.79
Deficit/passenger	$ 1.21	$1.51	$1.56	$1.11

[1]Excludes transfers and other non-revenue passengers. Total monthly ridership averaged 20,967.

[2]Includes exclusive-ride taxi ridership.

[3]Includes exclusive-ride taxi revenue.

[4]Includes exclusive-ride taxi and group ridership.

[5]Includes exclusive-ride taxi and group revenue.

[6]Cash flow accounting procedure may be misleading for short periods.

REFERENCES

1. City of Xenia, Model Transit Service Demonstration Project, Xenia, Ohio: First Year Report, August 1975.

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3. Multisystems, Inc., Evaluation Framework for the Xenia Service and Methods Demonstration Project, April 1976.

4. City of Xenia, Proposal to UMTA for Amendment of the City of Xenia, Ohio, Model Transit Service Demonstration Project, April 1975.

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APPENDIX G

KNOXVILLE TRANSPORTATICN BROKERAGE SYSTEM DEMONSTRATION PROJECT

OVERVIEW

The Knoxville Transportation Brokerage System (KTBS) Demonstration Project (TN-06-0006) seeks to establish and institutionalize a mechanism for coordinating a wide range of public and private transportation modes into an efficient, integrated regional network. KTBS will promote all forms of ridesharing by identifying and matching transportation supply and demand, acting to improve the legal and regulatory restrictions limiting the growth of ridesharing, and providing advice and information for those interested in rideshare modes. One component of this project is establishment of an area-wide vanpooling program, begun and promoted through the leasing of city-owned vans to groups of commuters with compatible travel patterns.

Under subcontract to the grant recipient (the city of Knoxville), the University of Tennessee (UT) Transportation Center will plan, manage, and operate KTBS. Funding for the demonstration, which is scheduled to run from July 1, 1975 to June 30, 1977, totals $1,116,539, consisting of $997,959 in federal SMD funds and $118,580 in local funds.

OBJECTIVES AND EVALUATION ISSUES

The KTBS Demonstration Project addresses three Service and Methods Program objectives:

(1) increased transit coverage;

(2) increased transit vehicle productivity; and

(3) improved service for the transit dependent.

Transit coverage is expected to expand to those areas where trip density levels do not justify conventional fixed-route service. Both rural areas and urban areas characterized by reverse-commute patterns should benefit. In addition, feeder lines to express freeway buses and taxi coordination services are slated for introduction and should increase the range of public transportation beyond its present scope.

Increased productivity is expected to result from the more efficient matching of demand and supply, i.e., arranging for the most appropriate available service to meet each identified need.

Service improvements for the transit dependent should be effected through innovative approaches toward providng services, such as midday use of commuter vehicles by social service agencies. KTBS will also seek to coordinate social service agency transportation resources and utilize taxis to supplement these resources in a cost-efficient manner. Commuter vanpools for the transit dependent have also been developed.

The project also addresses several local objectives, including:

(1) reduction in automobile vehicle-miles traveled (VMT), with attendant improvements in environmental and traffic conditions;

(2) reduction in energy consumption;

(3) provision of balanced transportation facilities for the low density areas;

(4) improved employment opportunities for the mobility limited;

(5) improved economic opportunities for small and minority businesses, primarily through provision of transportation services; and

(6) improved coordination among planning agencies.

In addition to these objectives, other issues to be examined in the evaluation of this demonstration include the institutional, legal, and regulatory aspects of the project; its organizational and technical planning and management; and the efficiency of its operations.

PROJECT DESCRIPTION

The SMD project in Knoxville involves a first attempt at implementation of the transportation brokerage concept on an area-wide basis. The broker function is being undertaken by the University of Tennessee Transportation Center, under contract with the city of Knoxville, with project staff composed of University of Tennessee professors, graduate

students, three full-time project employees, and Knoxville and Tennessee Bureau of Area Mass Transportation personnel. The University qualifies as an entirely new and independent organization to serve as broker, since it has no formal ties with existing transportation providers.

The planned range of broker functions, broker-arranged services, and target market segments is rather broad. In particular, the Knoxville Commuter Pool (the publicized name of the brokerage operation) will:

- identify (primarily through surveys and a telephone switchboard) the travel needs of commuters, social service agency clients, and the jobless.
- identify the existing and potential transportation suppliers: Knoxville Transit Corporation (fixed-route/subscription express bus), charter bus operators, taxi or limousine operators, individuals with cars or vans available for ridesharing, and small entrepreneurs with a fleet of available vehicles;
- acquire a fleet of 51 "seed" vans and make these available to private individuals on a lease basis; establish and operate maintenance, accounting, and control procedures for these vans;
- match potential passengers and transportation suppliers and foster, either formally or informally, agreements between riders and providers for pre-arranged service in areas currently not served by transit;
- act as ombudsman, providing information on available transportation services, costs, insurance, etc., and matching transportation demand with available supply;
- maintain liaison with Knoxville Transit Corporation, and various public agencies involved in the provision of transportation services and facilities; and
- actively promote institutional/regulatory modifications which will facilitate the operation of the brokerage system and/or the broker-managed services.

Commuter Vanpooling in Knoxville, Tennessee; City-Owned Vans are made available through the Transportation Broker.

These functions are being implemented through completion of the following twelve operational tasks:

1. Develop methods to increase public transit coverage - emphasis is on serving each activity center during its peak demand period as well as serving new activity centers located along interstate exits.

2. Locate employee groups that can be pooled - use of commuter surveys to determine the existing and potential degree of commuter concentration and propose sutiable ridesharing arrangements as follows:

   - Carpool - under 10 commuters with common O/D
   - Vanpool - 10-40 commuters with common O/D
   - Express bus - over 40 commuters with common O/D

3. Determine needs of social service agencies - examination of potential for midday use of commuter vehicles, increased use of taxis by social service agencies, and more efficient use of existing social service agency vehicles.

4. Determine needs of jobless who are dependent upon public transportation for job opportunities - emphasis is on serving employment centers not located on traditional transit routes.

5. Develop an operational vanpool program - start-up activities include obtaining vehicles, identifying potential drivers, contracting with ridesharers (identified in Task 2), determining insurance needs, and developing procedures for maintenance.

6. Develop an operational express bus program - involvement of private carriers as well as the public carrier (Knoxville Transit Corporation); activities include contracts-bidding forms, promotion, coordination, etc.

7. Develop programs to involve the private sector, especially small and minority businesses and existing para-transit firms - emphasis is on providing service for rural areas and weekend or holiday charter service; activities could range from an ombudsman function to assistance in obtaining loans.

8. Develop control and accounting procedures - emphasis is on developing control mechanisms to prevent

unauthorized use of vans, and/or developing operating procedures for vans.

9. <u>Develop regulatory structure required to manage brokerage programs</u> - addressing of issues regarding regulations, franchises, rate structures, liability, insurance, etc.

10. <u>Determine effectiveness of ridership program</u> - assessment of user acceptance, economic reliability, employer acceptance, energy effect, highway effect, effect on transit, and savings to social service agencies.

11. <u>Coordinate with highway and traffic groups</u> - coordination of public transportation services with highway facility planning, zoning, and traffic management functions.

SITE CHARACTERISTICS

Knoxville is the only major metropolitan area in eastern Tennessee and the site of the University of Tennessee. Located at the junction of rail and highway corridors, the city is a manufacturing and trade center with a population of 174,587 (average density 2,425 persons/square mile). The Knoxville SMSA (see Figure G-1) has a population of 400,337 (with an average density of 296 persons per square mile) and employs 148,732.

While the demonstration service area encompasses the sixteen counties of the Eastern Tennessee Development District (see Figure G-2) with a total area of 6,716 square miles, the major thrust of KTBS services will be the Knoxville SMSA. Initial project emphasis will be on serving commuters with vanpool and express bus service using publicly owned vehicles. Other elements, such as determining social service agency needs and involving the private sector, will be phased in after the vanpool/express bus operations have been in existence long enough to be visible and gain public acceptance.

With respect to private sector involvement, initial efforts will concentrate on small private bus companies serving rural areas. Other forms of private sector participation are anticipated to occur at a later time, after it has been demonstrated that the brokerage concept and vanpool operations are economically viable.

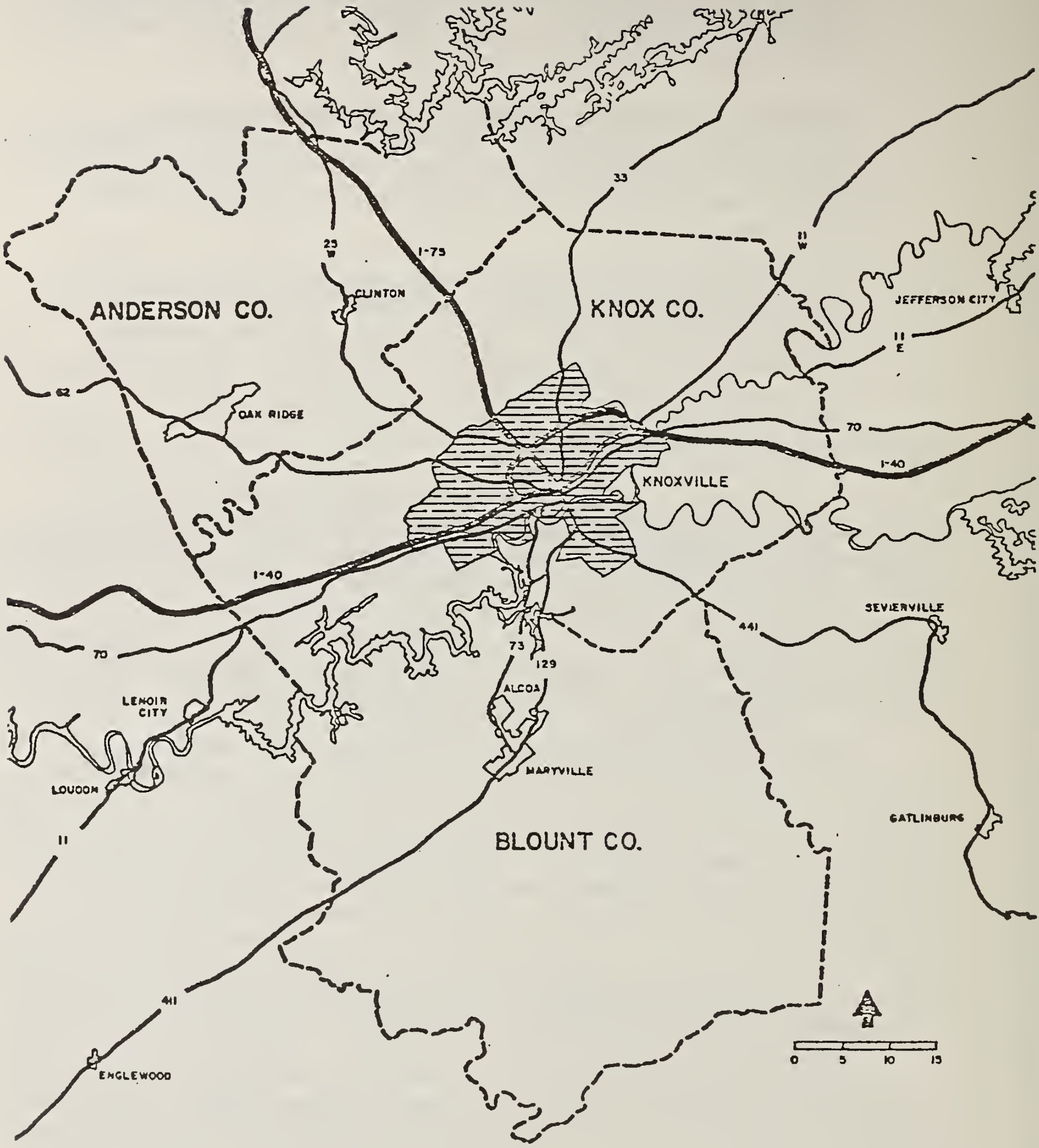


FIGURE G-1. KNOXVILLE SMSA

FIGURE G-2. KTBS SERVICE AREA

It is important to note that the activities to be undertaken during the two-year demonstration are being specified in a phased manner and are subject to extensive modification. The initial design of the project reflects the perceived needs and the institutional environment in Knoxville at its inception. As the demonstration progresses, the design is likely to change in response to schedule constraints, new perceptions of needs, altered institutional settings, and evolving knowledge about what is feasible and successful and what is not. Thus the ultimate form and scope of the Knoxville brokerage system may differ considerably from both the potential concept and the initially planned demonstration.

HISTORY AND STATUS

Although KTBS is the first organization promoting a variety of ridesharing modes on a regional basis, ridesharing is not new to Knoxville. A number of relatively successful employer-based programs have been operating in the area for some time. For example, the Tennessee Valley Authority (TVA), the largest employer in the area, began its express bus/vanpool program in March 1973; it now attracts about 30% of TVA employees.

The Knoxville Transit Authority, which operates the Knoxville Transit Company (KTC) provides the majority of traditional transit services within the city limits, and operates a number of special CBD-bound express bus routes serving the city's suburbs. Ridership has been decreasing steadily (except for these express services) and today KTC accounts for less than 3% of all trips in the SMSA.

The impetus for KTBS came from two prior studies by the University of Tennessee's Transportation Center which indicated the potential for strongly promoted ridesharing services in the Knoxville area. The University of Tennessee, with TVA's backing, convinced the city to apply for demonstration funding to establish the brokerage system; the grant was approved in October 1975.

Figure G-3 indicates the initial project schedule established for completion of the aforementioned eleven work tasks. The majority of these efforts are presently on or close to schedule. KTBS provides the impetus for State legislation permanently exempting commuter vehicles with passenger capacities of 15 or fewer persons from regulation by the Public Service Commission. It also worked with the insurance industry to develop an appropriate rating

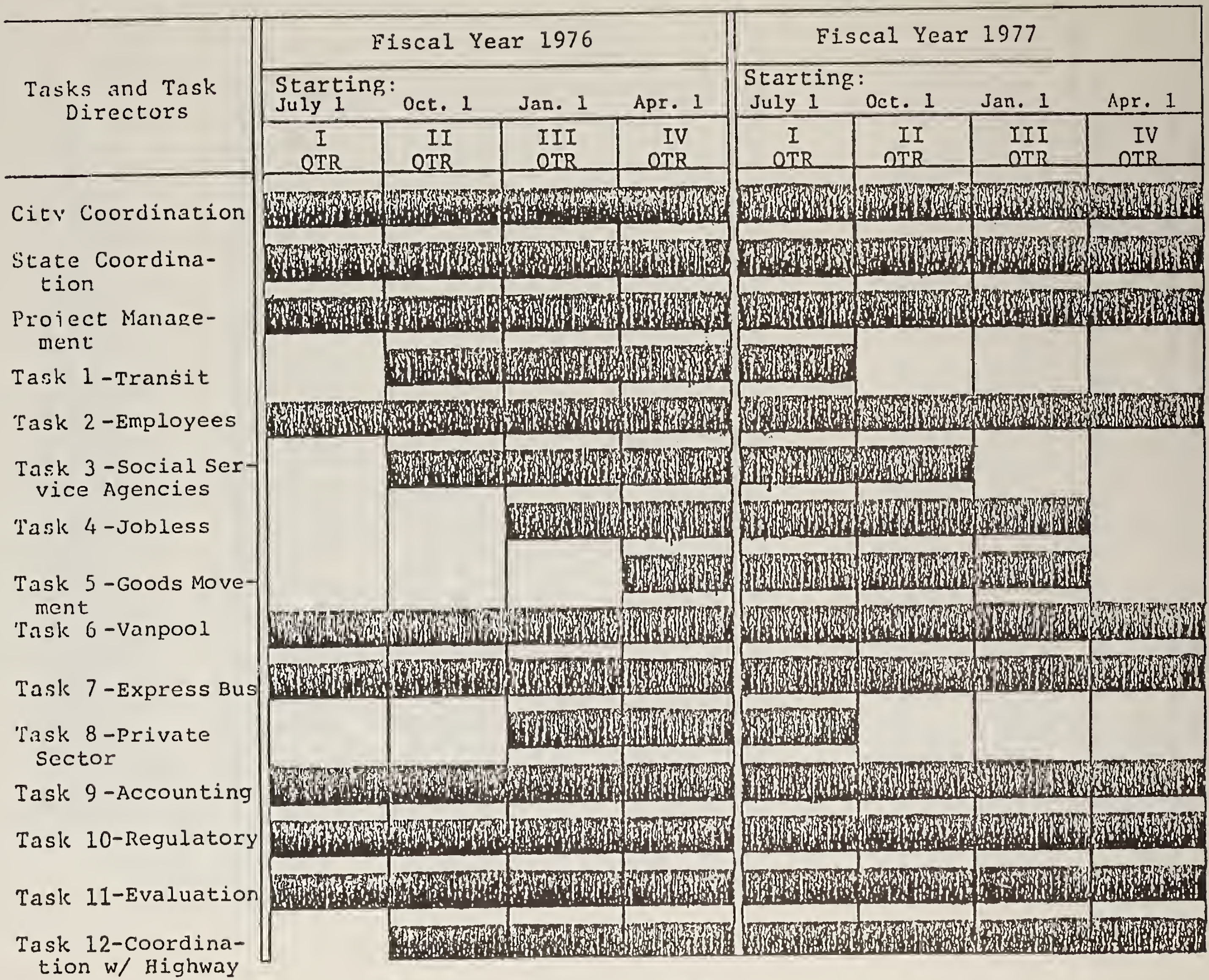


FIGURE G-3. PROJECT SCHEDULE

structure for private ridesharing arrangements; until then such arrangements had resulted in insurance rating as a common carrier.

The surveying of individual employees and of social service agencies is proceeding as intended, and formation of vanpools, although occurring more slowly than expected, is steadily increasing. (Much of the delay is attributable to computer problems which prevented the automated matching of commuters until June 1976.) By July 1976, 25 vanpools had been formed. The broker has recently identified the need for a feeder taxi service to operate in conjunction with an express transit route; plans call for establishing a pilot feeder system in September 1976.

FINDINGS

Although the major services of the Knoxville broker have yet to be fully implemented, there have been some important lessons learned from the project thus far. The most significant is the magnitude of the time and effort required to achieve institutional and regulatory changes. Despite the full support of State and local officials, the effort has been far in excess of what was anticipated by the projects' directors. Nevertheless, the project does provide evidence of the feasibility of institutional modification to permit innovative services. A second lesson has been that the formation of vanpools, at least at the outset of such a program, requires very detailed attention by the broker. It does not appear to be sufficient to provide the individuals with information. In general, however, it is too early to draw conclusions from the demonstration regarding the impact of KTBS on the transportation services in Knoxville.

In late 1976, the Knoxville city council passed an ordinance establishing a city Department of Transportation. One function of this DOT is to act as a transportation broker. For the first time the concept has attained legal status as part of an urban area's transportation system.

REFERENCES

1. City of Knoxville, "Preliminary Application for Federal Assistance for the Implementation of a Public Transportation Brokerage Service Serving Knoxville, Tennessee, and its Surrounding Commuter Areas," 1975.

2. CACI, Inc., "Evolution of the Knoxville Transportation Brokerage System," 1976.

3. Multisystems, Inc., "Evaluation Plan for the Knoxville Transportation Brokerage System Demonstration Project," 1976.

4. Transportation Center, University of Tennessee, _Ridesharing and the Knoxville Commuter_, 1975.

APPENDIX H

WESTPORT INTEGRATED TRANSIT SERVICES DEMONSTRATION PROJECT

OVERVIEW

The Westport Integrated Transit Services Demonstration Project (CT-06-0007-1) is designed to establish a wide range of integrated transit services under the jurisdiction of the Westport Transit District (WTD). The WTD, a public authority, will coordinate the design, implementation, and operation of fixed-route bus service, shared-ride taxi service, special market demand-responsive services, special market subscription bus service, and a carpool, and vanpool program for local residents. WTD currently operates the fixed-route bus system, and will act as a broker to negotiate and contract with local taxi operators to provide shared-ride and demand-responsive services. Integrated services will be provided by the current fleet of eleven mini-buses and twelve new vans, coordinated through a central dispatch office that is staffed and operated by the WTD. Funding for the demonstration, which is scheduled to run for a period of two years beginning July 1, 1976, totals $788,841, consisting of $635,000 in Federal SMD and $153,841 in local funds.

Public transit was initially established in Westport just three years ago after the community instituted a Transit District and implemented a series of fixed-route buses which meet at a timed transfer point near the center of town. Since then, the Westport residents have heavily patronized the service, and demands for new and expanded services prompted the demonstration project.

OBJECTIVES AND EVALUATION ISSUES

The following Service and Methods Demonstration Program objectives are addressed by the Westport demonstration:

1) Integrated transit coverage

   Expansion of service into the evening, the addition of new routes, and an increase in the number of commuter service runs are being implemented.

2) Improved transit vehicle productivity

The WTD seeks to improve the current levels of productivity on services it provides directly, as well as significantly improve productivity of existing private sector operations. Specifically, productivity improvements could stem from an increase in ridership on the commuter fixed-route system, an increase in taxi ridership, and a decrease in overhead and control costs as a result of consolidating dispatching of all services into a single control room. Productivity improvements could also result from a profit incentive program directed at the taxi operators and dispatcher.

3) Improved service for the transit dependent

The WTD is seeking to expand its services to the very young, the elderly, and the physically handicapped through the efficient provision of door-to-door service and the spatial and temporal expansion of fixed-route services.

Local project objectives relate to the use of the automobile by Westport residents. They are:

1) Reduction of automobile commuter traffic at the Westport commuter rail stations and within downtown Westport.

2) Reduction in automobile ownership.

Evaluation of the Westport demonstration will focus on two major issues:

1) The integration of many public transportation services into one operating unit. The evaluation will address legal, institutional, administrative, technical, and coordination groundwork required to establish an integrated system. Particular emphasis will be placed on the interaction between WTD and local taxi operators.

2) The role of a public transit agency as a broker. The evaluation will focus on the interaction of WTD and all facets of system operation, including WTD policies towards maintenance, drivers, dispatchers, and the town of Westport.

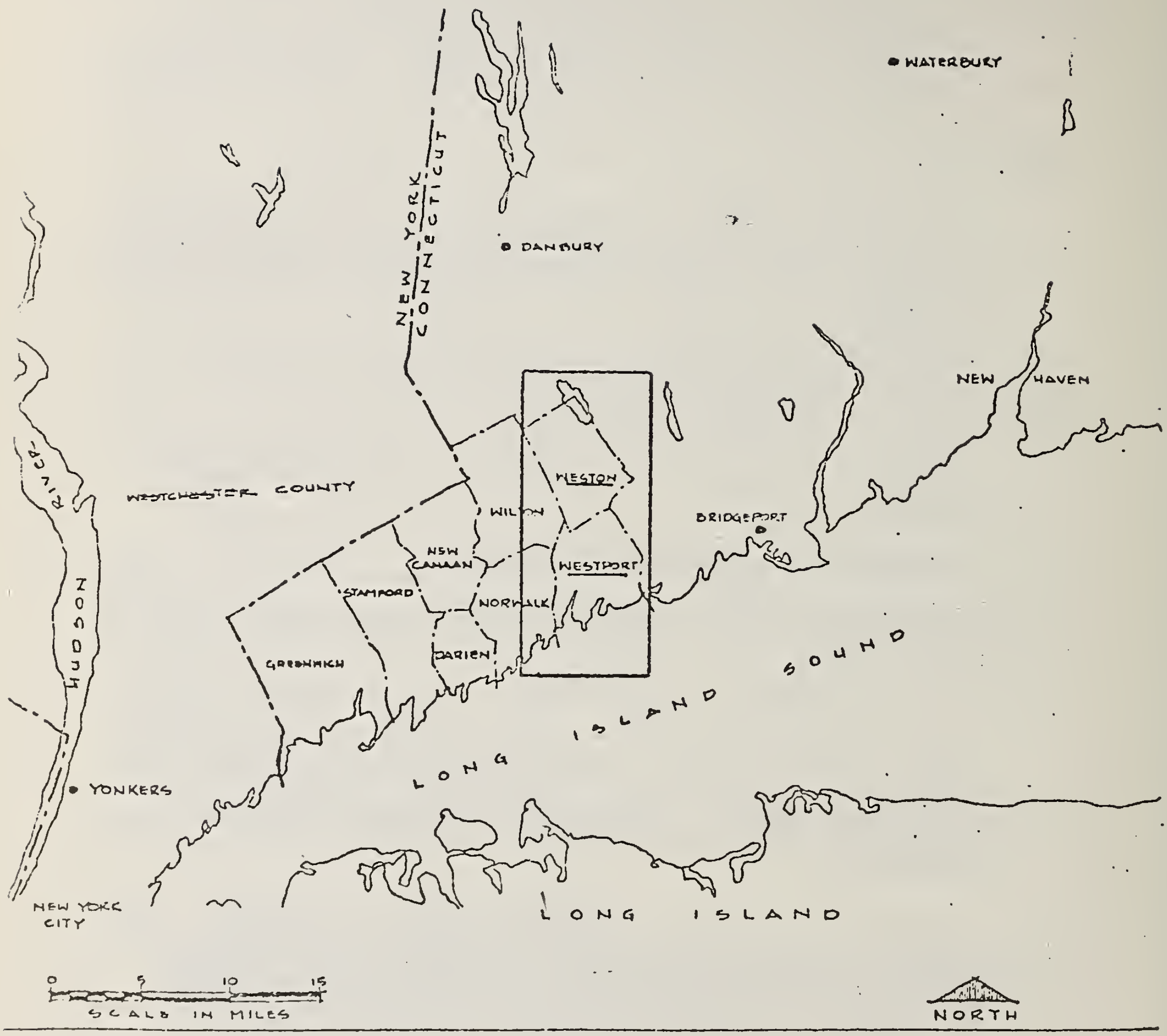


FIGURE H-1. SOUTHWEST CONNECTICUT REGION

Bus Service Providing Transportation to
Commuter Rail Station, Westport, Connecticut

Buses Parked at the Central Transfer Point,
Westport, Connecticut

PROJECT DESCRIPTION

Site Characteristics

Westport is situated on Long Island Sound, about one hour's drive from New York City (see Figure H-1). The town encompasses roughly 22 square miles, and has a population of 28,000 people, resulting in a relatively low population density of 1,300 persons per square mile.

Perhaps the most unique characteristic of Westport is the relative affluence that its residents enjoy. The average income of Westport residents is over $21,000 (after taxes), and the average auto ownership is well over two cars per household. About 8 percent of the community's residents are over 65 years of age.

Because of its proximity to New York City, many Westport residents are employed in New York City. Commuters can drive, or take a Penn Central commuter train into the city. Commuter trains run frequently during the morning and afternoon peaks.

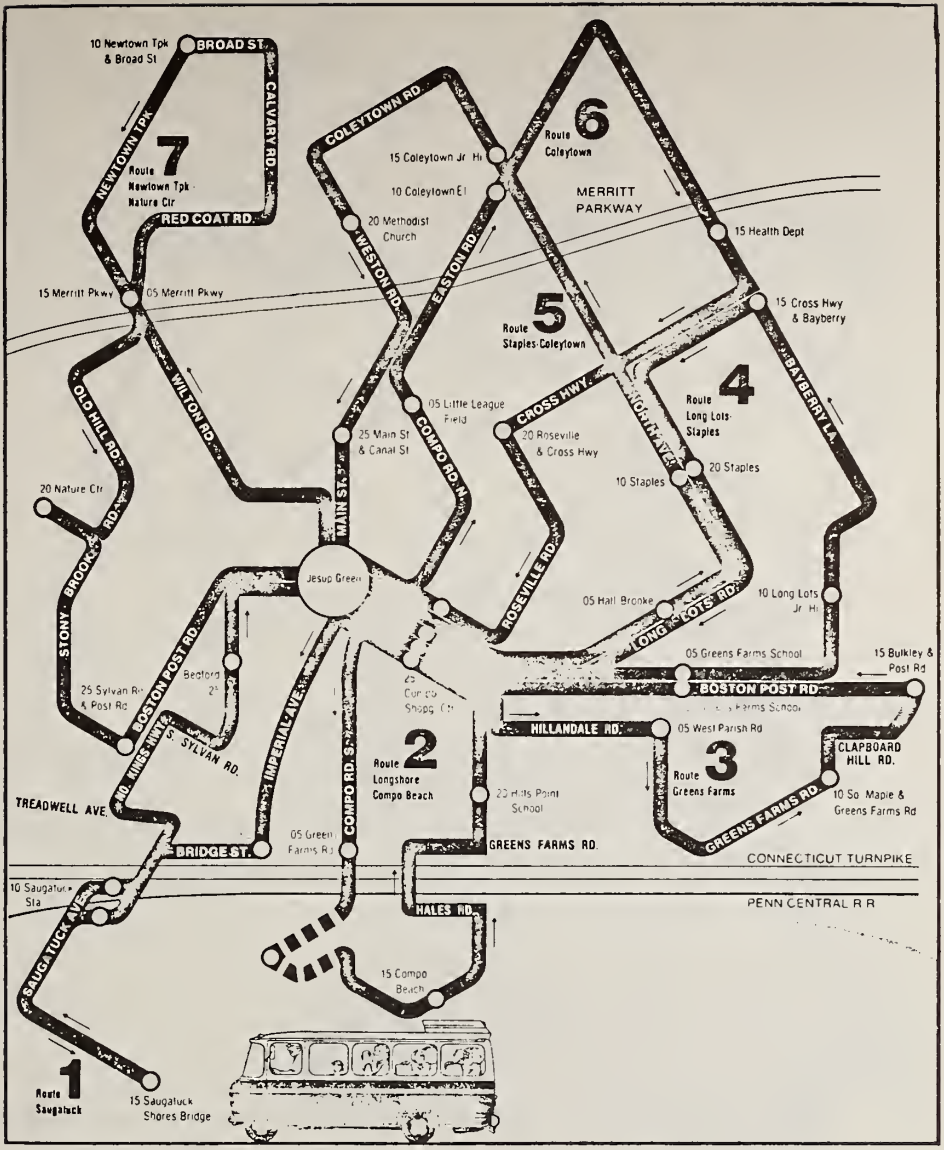
Project Description

Bus service was initiated in Westport in 1974 when the Westport Transit District was created through community support. The WTD has the authority to operate all transit vehicles in the Westport community.

The route structure adopted at that time and currently in operation was a series of seven fixed-route loops which meet at a common transfer point near the center of town. Each route has a run time of 30-35 minutes, and a timed transfer is coordinated in the center of town (see Figure H-2). This service is offered continuously from 7:45 a.m. to 5:30 p.m. Vehicles can be hailed anywhere along the routes, as there is no designated system of bus stops.

Prior to and upon completion of daytime service, the WTD uses the same vehicles to provide commuter service to Westport's commuter rail stations. Commuter service, provided from 6:30 a.m. to 7:30 a.m. and 5:50 p.m. to 7:30 p.m., consists of seven routes covering the areas directly surrounding the commuter stations (see Figure H-3).

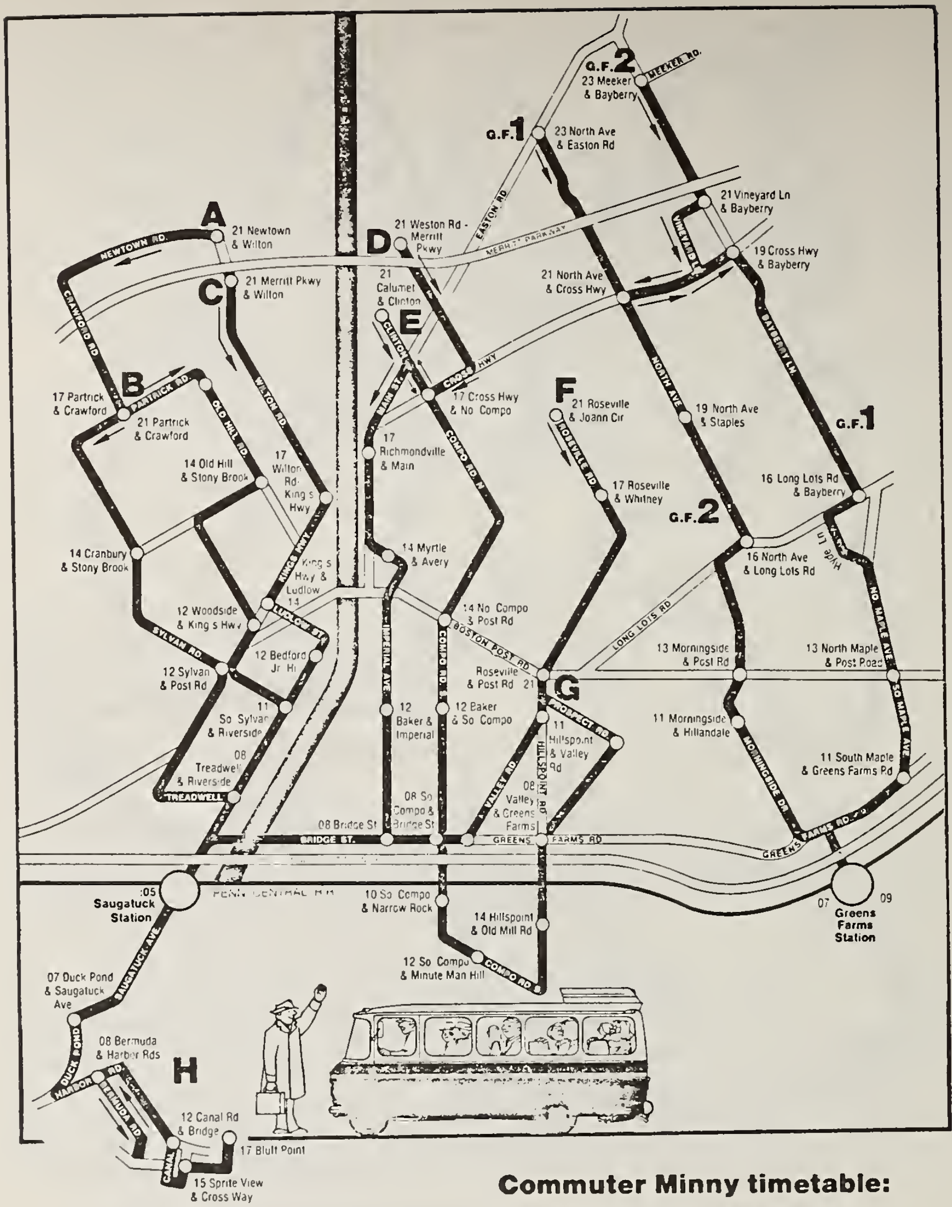
The vehicle fleet consists of eight 16-passenger minibuses and two 33-passenger small-transit coaches. Seven vehicles are in active use, and three vehicles are



Here's where and when to find the Minny

The numbers indicated at each point represent minutes from Jesup Green. Buses on the Daytime Route depart from the Minny Terminal at 7:45 8:20 8:55 9:30 10:05 10:40 11:15 11:50 12:25 1:00 1:35 2:10 2:45 3:20 3:55 4:30 5:05

FIGURE H-2. WESTPORT TRANSIT DISTRICT



Commuter Minny timetable:

Note: To find the time Minny will be at your stop in the morning, "count down" or subtract the indicated number of minutes from train time. If evening trains are late — we'll wait at least til 8 p.m.

Saugatuck Trains	Greens Farms Trains
7:09 AM	7:04 AM
7:32	7:27
*5:02 PM	*4:40 PM
*5:20	*5:20
*6:07	*6:07

*Leaves Grand Central

FIGURE H-3. WESTPORT COMMUTER ROUTES

maintained as a back-up fleet. The vehicles are garaged and maintained by contract to the local school bus operator in Westport. WTD has been operating a preventive maintenance program.

The WTD fare structure is rather unique. Users have the opportunity to purchase an annual pass which entitles the passholders to unlimited trips on the system for an entire year. The annual passes are priced modestly, with discounts for family plans and transit captive groups (young, elderly):

Husband and wife	$45.00
Children bought with above	15.00
Children alone	25.00
Elderly (over 62)	15.00
Single Adult	30.00
College students living away	20.00

A single fare and transfer can be purchased for 50 cents, except that the elderly and handicapped are charged only 25 cents.

The system has recently reached capacity, particularly for commuter service and during the mid-afternoon period. A need to serve increased demands and a desire to expand temporal and spatial elements of service prompted design of the demonstration project.

The most important feature of the Westport demonstration is the integration of conventional transit services provided by the District and new paratransit services to be provided by a private operator. It will bring a range of services under a single management system. The District will contract with one or both of the Westport taxi operators to provide paratransit services using vehicles owned by the District. The company will provide personnel, supervisory, and management functions. All revenues generated by the service would belong to the Westport Transit District.

A crucial element in this integration is the implementation of a single control center to dispatch and monitor the operation of all transportation services. The new services of the demonstration project are:

1) <u>Shared-Ride Taxi Service</u>

An integrated taxi service will offer shared-ride as well as small package delivery. Fares will be

approximately 40% lower than in current taxi operations and a goal has been set of doubling current productivities. The service will be provided through a single dispatch center and would require active use of four of the twelve vans to be purchased as part of the demonstration. The shared-ride taxi service will provide complementary service to the fixed-route buses during periods of low demand. Fares for the shared ride service will be integrated with the current pre-paid annual pass system used by the District.

2) Supplementary Fixed-Route Service

Greatly increased commuter service will enable the District to service twice as many commuter trains. The new van fleet will serve late morning trains while minibuses are providing daytime service. Daytime service will be expanded through the addition of an eighth route to serve the Saugatuck area. Daytime service will be extended to provide additional hours of service during the early evening and on Friday and Saturday nights.

3) Special Market Services

Advance-request demand-responsive service will be available for special user groups such as the elderly and handicapped and for organizations such as daycare centers who wish to subscribe for special services. One van will be equipped with a lift to serve handicapped persons.

4) Transportation Brokerage

The Transit District will develop and expand its role as a transportation broker for the community. Pooling will be promoted as part of the overall public information program. Technical assistance will be provided in forming pools. Assistance in implementing subscription van programs will be provided to main employment centers in the community including the CBD. In addition, the Transit District will explore the possibility of developing a program for utilizing occasional providers of paratransit service. Rather than add additional equipment to meet growing demand for some transit services, the District would pay individuals driving their own vehicles to provide supplementary service on certain routes during peak periods.

All demonstration services will be provided by the original fleet of ten vehicles, by seven additional vehicles (3 minibuses, 2 coaches, and 2 vans) pending approval of a Capital Grant, and by 12 vans to be purchased through the Demonstration Grant. Vans will be used for shared-ride and demand-responsive services, while minibuses and coaches will be used for fixed-route service. Vans may be used on fixed routes at times of low demand or as a supplement to minibuses and coaches at times of high demand. Vans, minibuses, and coaches will be used for subscription service, depending upon the level of demand.

The WTD will be initiating a new fare structure as a result of the new services. However, at this time the exact nature of these changes is not known.

In order to ensure that the shared-ride service is being performed efficiently by the taxi operators, the WTD will institute a profit incentive program where taxi operators will be rewarded with higher profits when achieving higher system productivities. The profit bonus arrangement will be similar to the following:

Units of Profit Per Passenger ($)	System Productivity
.05	≤2.0
.06	2.1 to 2.5
.07	2.6 to 3.0
.08	3.1 to 3.5
.09	3.6 to 4.0
.10	≥4.1

HISTORY AND STATUS

To date, demonstration activity has been related to structuring and planning the integrated services. Since the demonstration began on August 4, 1976, the Westport Transit District has opened and closed bids for the new vans and radios, with the new equipment due to arrive by March 1, 1977. In addition, WTD has been conducting negotiations with the two taxi companies located in Westport. At the present time, this issue is unresolved.

Provided that the events discussed above remain on schedule, new service will commence on March 12, 1977.

APPENDIX I

ST. BERNARD TAXICAB FEEDER TO BUS SERVICES

OVERVIEW

This project is the first in the U.S. to involve shared-ride taxicab service as feeders to bus services, with convenient transfer mechanisms such as joint fares and sheltered bus stops. This concept of integrating taxicabs with conventional and subscription bus service will be tested in St. Bernard Parish (population 60,000), a low density suburban area of New Orleans, Louisiana.

The two-year demonstration project, which began in June 1976, will support the expansion of a pilot taxi feeder service which has been operating in a portion of the area since 1974. During the demonstration period, bus service will be improved and feeder service will be introduced throughout the entire bus area. The project is being managed by the St. Bernard Parish Planning Commission, and the service is being provided by two private companies: Arabi Cab and St. Bernard Bus. The project is supported by an UMTA demonstration grant of $325,350, $103,800 of which will be used for the purchase of buses, shelters, and taxicabs.

OBJECTIVES

The primary objective of the Service and Methods Demonstration Program (SMD) addressed by this project is that of increasing coverage of transit service. The project is part of a broader effort designed to assess the extent to which transit coverage in low density areas can be increased in a cost-effective manner by shared-ride taxicab feeder services. A local objective is to develop a viable feeder service that will require little or no subsidy after the demonstration.

PROJECT DESCRIPTION

Persons in St. Bernard can telephone the taxi company and request shared taxi service to either of the two local bus routes. The cab pick-up time is coordinated by the dispatcher to minimize the passenger wait-time at the designated transfer points. The fact that buses arrive at

Transferring from Fixed-Route Bus to Shared-Ride
Taxi, St. Bernard Parish, Louisiana

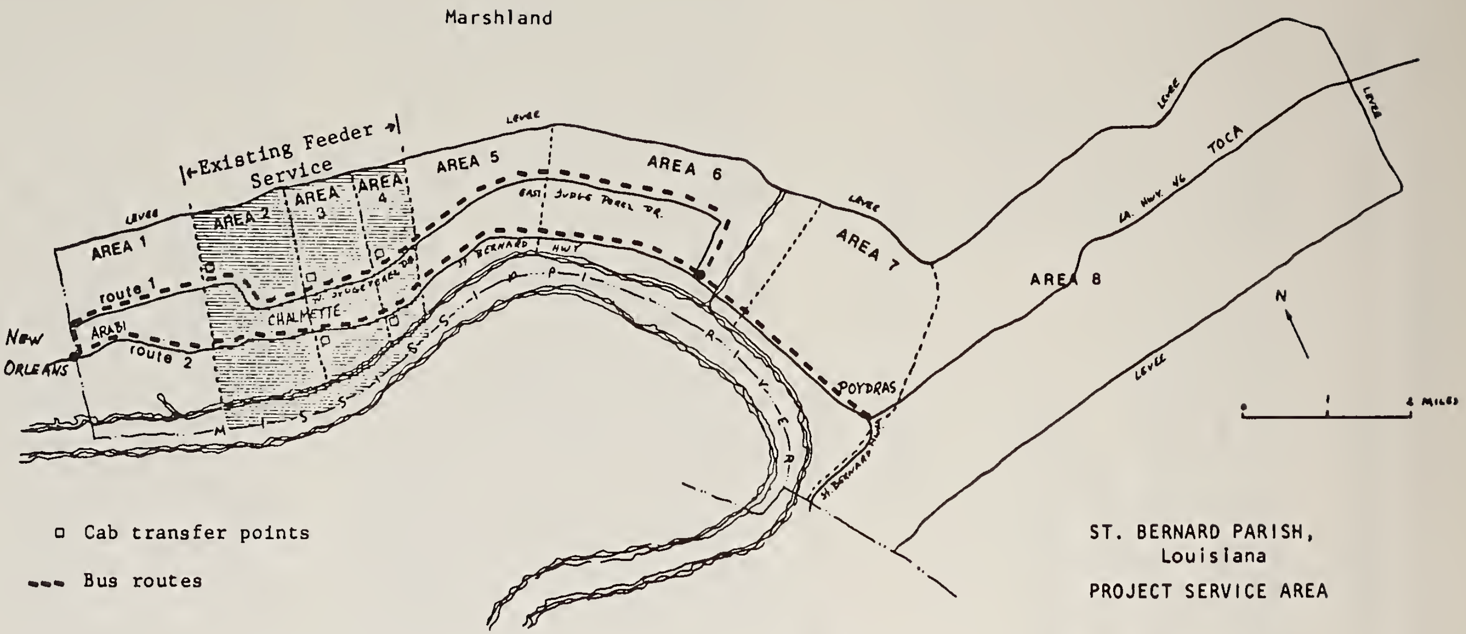
regularly scheduled times facilitates the matching of two or more riders for the same cab. On the return trip, the bus passengers tell the driver that they wish a bus-cab transfer and the bus driver indicates to the dispatcher when and at which transfer point the passengers will be discharged. Available cabs then pick up the riders and deliver them home. The user pays a joint fare during peak periods of between $0.60 and $2.25, depending on the length of the trip. Approximately $0.50 of this covers the taxi portion of the trip. During offpeak times the regular fares are $0.10 less, and the elderly and handicapped can ride for half fare.

The taxicab operator provides feeder and conventional taxi services within the Parish with a fleet of twenty 5-passenger automobiles and nine 7-passenger vehicles. The taxi drivers receive a portion of the joint fare when they provide a transfer.

St. Bernard has two regularly scheduled bus routes that run parallel to the Mississippi River (see Figure I-1). The Judge Perez route (No. 1) runs about nine miles through suburban neighborhoods and scattered strip commercial areas with two buses providing service on one-half hour headways each weekday from 6:00 a.m. to 6:00 p.m. The second route on the St. Bernard Highway extends over ten miles toward the rural portion of the Parish with three buses operating on twenty minute headways Monday through Friday, and less frequently on Saturday. There are eight bus fare zones (the designated areas in Figure I-1) and the charges range from $0.25 to $1.85 for a one-way trip (half fare for elderly and handicapped persons).

During commute hours express buses leave from the western edge of the Parish and travel non-stop to the CBD of New Orleans for a fare of $0.40. A combination taxicab feeder and express bus service operated on a subscription basis is planned. Taxis will pick up regular commuters in Areas 1 through 4 at specified times and deliver them to the bus terminal for a direct trip to downtown New Orleans. The fare will be $1.00 each way.

Table I-1 presents selected demographic data for the Parish based upon the 1970 Census.



Source: St. Bernard Parish Planning Commission

FIGURE I-1. ST. BERNARD PARISH - PROJECT SERVICE AREA

TABLE I-1

DEMOGRAPHIC DATA - ST. BERNARD PARISH

Population	51,185
Persons Per Acre	9.4
Number of Families	13,978
Mean Income	$9,646
Autos Available	9% none 48% one 36% two 6% three plus

Source: 1970 Census.

PROJECT HISTORY AND STATUS

In 1973 the owners of the cab company formed the present bus company after the previous bus operator went out of business. They believed that taxi usage was adversely effected by the termination of bus service and they hoped that a combination of both operations would be profitable. In October 1974, to save some of the bus operating costs, service on the Judge Perez route was reduced and shared taxi feeder service was introduced along a portion (Areas 2 through 4) of both bus routes. Users were charged a joint fare of between $0.50 and $0.85 and ridership has gradually increased to about 1,000 trips per month. This pilot operation demonstrated that high quality integrated service could be provided and that people would use it, and was sufficient to interest UMTA in developing a larger test of the concept.

There are three major phases planned for the project. During the first year, the existing bus service provided with three 40-passenger vehicles will be improved by adding two new buses and four passenger shelters. The existing 20-vehicle taxi fleet will be expanded by the taxi operator as demand warrants by leasing up to nine 7-passenger vehicles purchased by the Parish under the project. In the second phase, shared taxi feeder service will be introduced to other service areas and the fares for the current taxi transfers in Areas 2 through 4 will be increased to between $0.60 and $1.15. In the second year, the combination of

shared taxi and subscription bus service for commuters will be started.

FINDINGS

There are no results available as yet since the project and monitoring effort has just begun.

APPENDIX J

RESTON COMMUTER BUS SERVICE DEMONSTRATION PROJECT

PROJECT OVERVIEW

Reston Commuter Bus (RCB), Inc., is a community initiated commuter bus service operating between major Washington, D.C. employment centers and Reston, Virginia. It has grown in both ridership and sophistication of service since its initiation in 1968. Instead of owning buses, RCB has been contracting with a number of carriers both in public and the private sectors.

RCB has received no Federal funding and its service is independent of UMTA's SMD Program. Because of the potential applicability of this approach to commuter travel, the Reston experience has been analyzed and documented for dissemination to other communities through the SMD Program.

OBJECTIVES AND EVALUATION ISSUES

The following three SMD objectives are relevant to RCB operations:

1) reduced travel time;

2) increased transit coverage; and

3) increased transit vehicle productivity.

RCB operating strategies have reduced bus travel time through bus scheduling policies based upon demand, the use of coordinated transfers at centralized points, and preferential freeway access.

Increased transit coverage is implicit in the fact that a mass transit system now operates where there otherwise would most likely have been none. Coverage has also been enhanced through increased route specialization.

Similarly, increased transit vehicle productivity is manifested in the high ridership generated for trips where the only other alternative is the use of the private automobile. Moreover, by effectively matching supply and demand (except for a short period where a subsidy was received from Fairfax County, VA), all costs have been

covered by fares in an era where most transit operations are heavily subsidized.

In addition, RCB management has emphasized the following service-related local objectives:

1) minimized crowding (thus providing a high degree of passenger amenities); and,

2) maximized ridership options (through "straggler bus" provisions), route scheduling that approximates as much as possible a one-to-one type of service, and increased service frequency.

RCB is neither a transit authority nor a common carrier, but it has assumed the responsibility for providing bus service to Reston. As a result of this unusual position, institutional and regulatory issues have figured heavily in RCB's development.

Since Reston is part of the Washington, D.C. metropolitan area, it falls within the service area of the Washington Metropolitan Area Transit Authority (WMATA), which operates transit services in the metropolitan area. Over the course of its development, RCB has been perceived as both client and competitor to WMATA. Legal decisions with regard to institutional and regulatory issues have received nationwide attention.

The viability of providing self-supportive transit service in an era of heavily subsidized transit operations constitutes another major issue. RCB's experiences with regard to cost and revenues and methods by which RCB has managed to operate in the black is of national interest.

Citizen participation has also played a key role in RCB's development. Unlike many commuter bus services, RCB is a public institution that, with the exception of bookkeeping and routing clerical functions, is operated through active, noncompensatory citizen participation.

SERVICE DESCRIPTION

Reston, Virginia, is a planned unit development, or "newtown," approximately twenty miles west of Washington, D.C. Although Reston was conceived as a self-contained newtown, implying mixed land uses and little necessity for long distance commutes, its residential development has preceded planned commercial, office, and light industrial

construction. Thus, the commuting patterns in Reston have been similar to those in other Washington suburbs, with a high proportion of white-collar, Federal government workers commuting to downtown Washington and nearby employment centers in Virginia, such as the Pentagon, Rosslyn, and Crystal City. Reston's location with respect to the Washington, D.C. metropolitan area is depicted in Figure J-1.

Reston has some unusual characteristics, when compared to most United States communities, such as a high median family income, a high median level of education, and a high degree of citizen involvement in community affairs.

The RCB Service essentially consists of three time-sequenced components: passenger collection, express line-haul, and passenger distribution. In addition to these activities, there exists, as an essential element of the system's operation, a transfer procedure, converting the passenger collection service into a feeder service to the line-haul component serving an array of destinations, both morning and evening.

System buses are currently operated under contract by Colonial Transit Company, Inc., of Fredericksburg, Virginia. In the morning, 6:30 to 8:30 a.m., these buses circulate through the Reston community providing a collection service which is responsive to changes in demand and which covers virtually all areas of Reston. Currently, 92% of the system users access the REC by walking. Of these, 67% walk one block or less, and 95% walk three blocks or less. Routes within Reston change frequently, to be responsive to changing concentrations in demand.

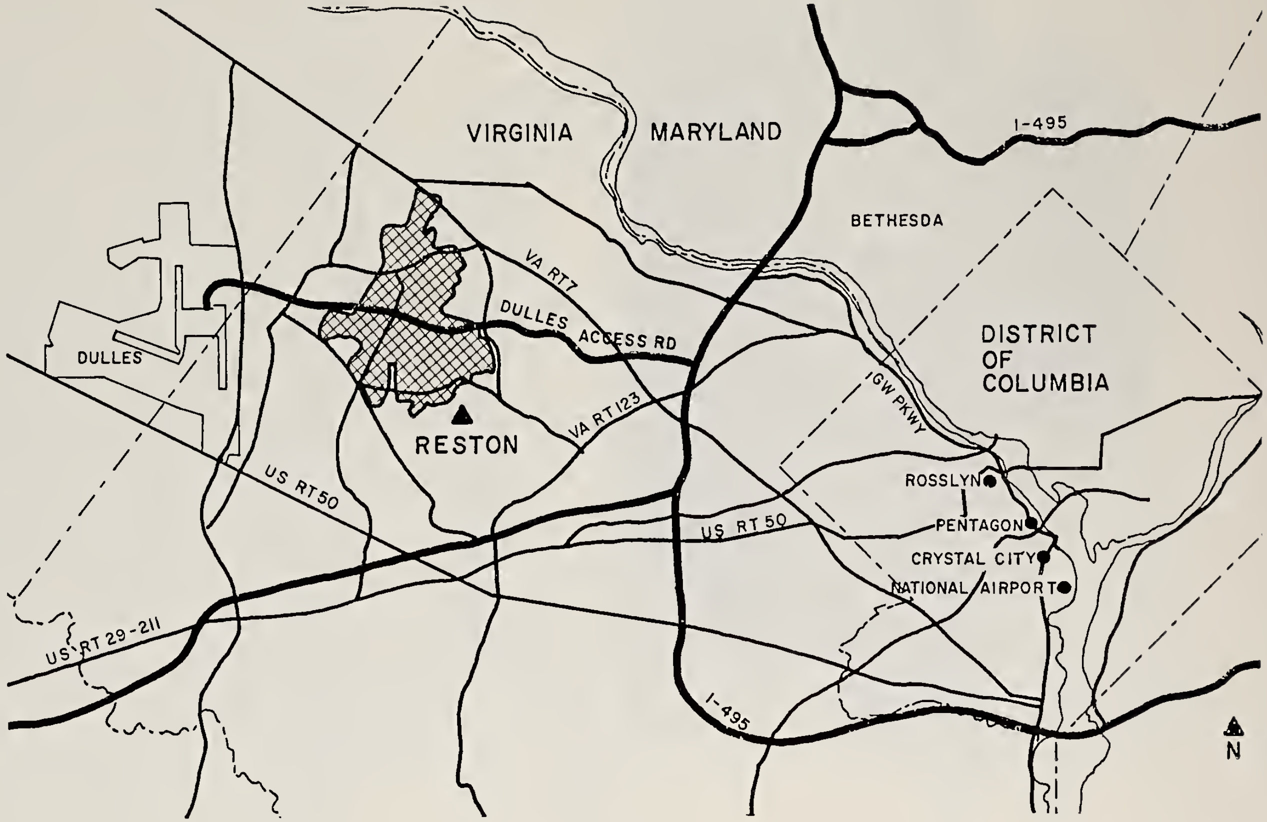


FIGURE J-1. RESTON AND THE METROPOLITAN WASHINGTON, D.C. AREA

General Motors 4104 coach used by
Colonial Transit for RCB service

The buses converge, on a fixed schedule, at a preferential freeway access point consisting of exclusive bus ramps to and from the Dulles Airport Access Highway (see Figure J-2). At these ramps, during the morning period, several buses arrive at the same time and passengers transfer to the bus most nearly satisfying their destination requirements. (Enforcement of the exclusive bus ramp access is accomplished through electronic sensors that distinguish between the presence of buses and other vehicles, and card-activated lift-gates.) This transfer activity is accomplished in a minimum amount of time, constrained only by the numbers of people involved and, perhaps, weather conditions. The buses then embark on the express line-haul component of the service to destinations in the District of Columbia and nearby Virginia.

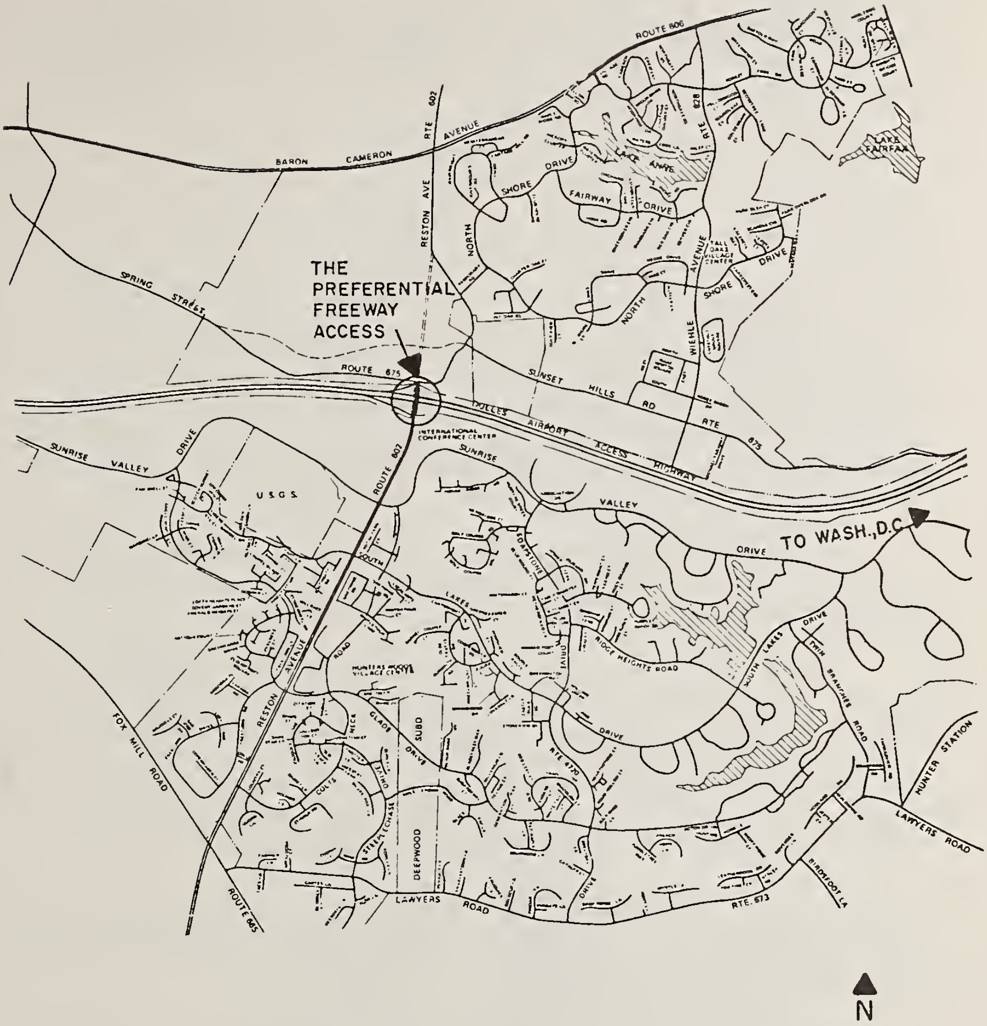


FIGURE J-2. THE RESTON COMMUNITY

Buses follow three major routes in the District of Columbia, as can be seen in Figure J-3. In addition to these D.C. routes, Virginia buses drop passengers off at four major destinations: Rosslyn, The Pentagon, Crystal City, and the Washington National Airport (Figure J-1). Many of the RCB buses park during working hours at a peripheral lot located near The Pentagon. Others are parked by the drivers at a point near to their work destinations or are put into service by the Colonial Transit Company during the offpeak period.

During the evening peak periods (approximately 4:15 to 6:00), the RCB buses make their passenger pick-ups at various work locations and at specifically identified pick-up points along the return routes. Most of the RCB buses converge on Rosslyn, Virginia, where transfers are made to an RCB bus which would provide the most desirable drop-off service point in Reston. Transfers at Rosslyn range from one to six minutes depending upon the arrival time of the buses. Once transfers have been made, the bus then enters the express line-haul portion of the service and proceeds to Reston, Virginia, by way of the George Washington Parkway, I-495 (the beltway surrounding the District of Columbia area) and the Dulles Airport Access Highway. Upon reaching the exclusive bus ramp, most buses proceed on to their destination routing within Reston. In some instances, transfers are made at the bus ramp by individuals who had been unable to make transfers at Rosslyn.

To enhance the evening service, a "straggler" bus makes a final trip for those individuals who work beyond their planned departure time, leaving Rosslyn at 7:26 p.m.

Although RCB service is provided by a private carrier, daily operational responsibilities (e.g., fare collection, record keeping, interaction with drivers) are handled by volunteer "busmeisters," Reston commuters who also function as liaisons between passengers and system administration. These busmeisters ride for free and, after a period of time, may be elected to the Board of Directors.

The RCB buses, primarily older (1957-1960) over-the-road coaches, are stored at night near Dulles Airport, about five miles west of Reston. (In the fall of 1976, the contract fleet consisted of 67 buses.)

The present fare structure, which has remained in effect for over a year, is as follows: $15 ticket card, good for ten rides; one dollar and seventy-five cents cash for single (one-way) rides; and, twenty-five cents cash for

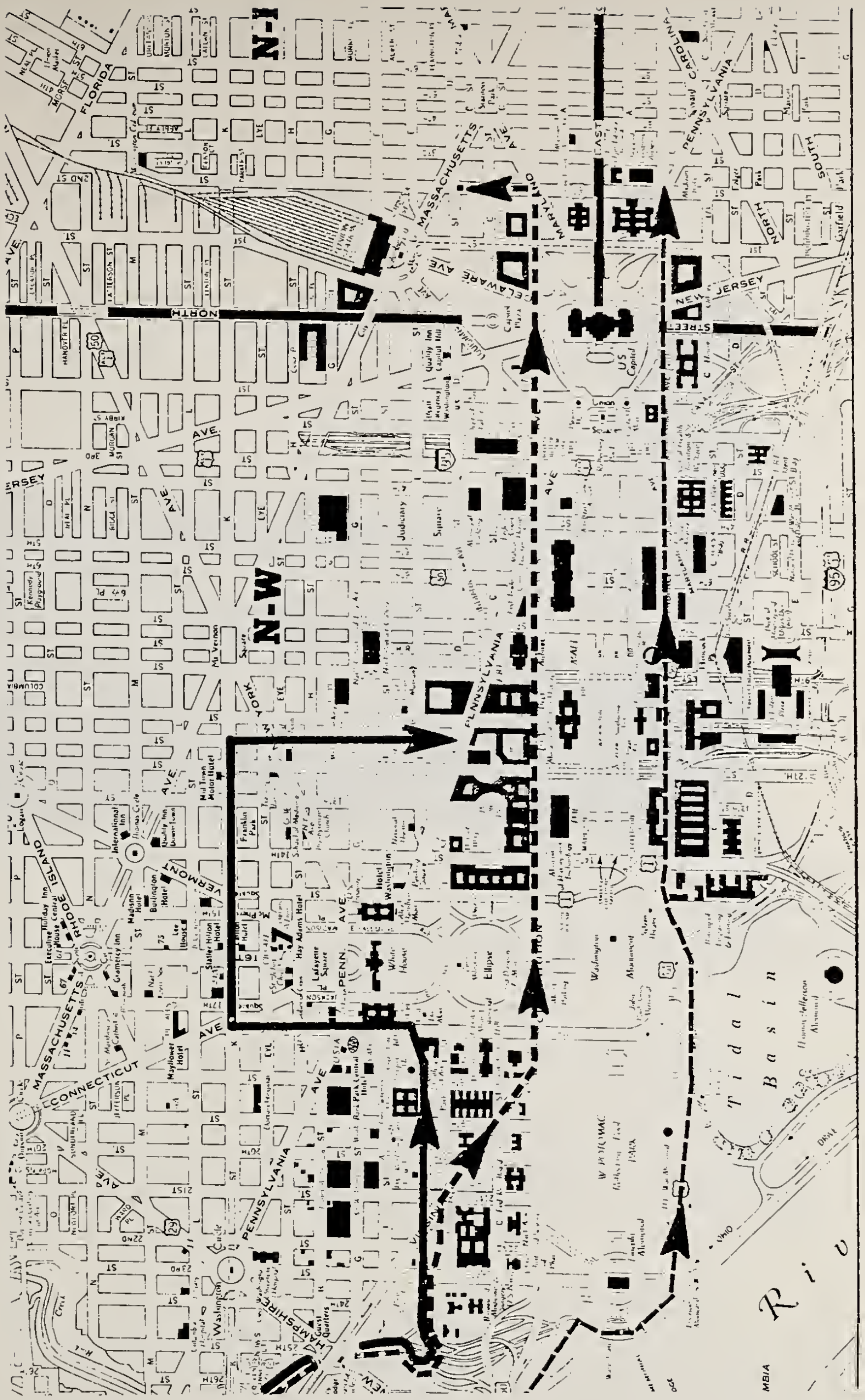


FIGURE J-3. RCB ROUTES IN WASHINGTON, D.C.

Many RCB Buses Park During Working Hours at a Peripheral Lot near the Pentagon.

retired senior citizens on an occasional basis, as approved by the RCB Board of Directors.

HISTORY

The RCB system has passed through three phases:

1) organizational development (1968-1970);

2) service development (1970-1973); and

3) institutional reorganization (1973-1976).

RCB began operations in 1968 under the sponsorship of the Reston Community Association, a local civic association of elected representatives with a broad interest in issues and policies affecting Reston. RCB subsequently sought and obtained a non-profit corporation charter from the Virginia State Corporation Commission. It is organized and operated in accordance with bylaws established by the board of directors.

During the organizational development phase, RCB established itself as a corporation with the means for managing a comprehensive bus system. Most operating procedures, formal and informal policies, and working relationships within the volunteer organization were developed during this phase. Originally, RCB contracted with the Washington, Virginia and Maryland (WV&M) Coach Company, a subsidiary of D.C. Transit. WV&M and D.C. Transit were absorbed by WMATA, which agreed to continue providing RCB service. (The change from WV&M to WMATA was the result of a public takeover and was outside the control of RCB.)

The service development phase saw great system expansion and service improvement. Routes were expanded and the system grew from 17 to 51 daily runs. It was during this time that RCB received permission from the Federal Aviation Administration to construct preferential freeway access ramps to and from the Dulles Highway. Construction of the ramps was funded by Gulf Reston, Inc., the Reston development corporation.

However, WMATA service entailed many financial considerations not formerly encountered: extensive deadheading was required; drivers were paid full-time wages (and even overtime) while providing only peak-hour service; and interpretation of the cost-recovery billing procedure

was subject to dispute. Overall, toward the end of this phase, RCB felt that service was deteriorating, while costs were rising.

During the institutional reorganization phase, RCB cancelled its contract with the public transit authority and contracted instead with a private carrier, at a significant cost saving. The private carrier, Colonial Transit Company, Inc., employs non-union bus drivers, many of whom hold regular jobs in addition to their bus-driving responsibilities. RCB's relationship with Colonial Transit has generally been satisfactory. Since Colonial drivers are not full-time drivers, they can provide peak-hour commuting service to Reston residents and still work full days at their places of primary employment, being compensated only for driving hours.

The change by RCB to Colonial Transit was opposed by WMATA on the basis that the Reston service was regular route service and could only be supplied by WMATA. The case was argued before the Washington Metropolitan Area Transit Commission which decided in favor of Colonial Transit and issued a certificate allowing them to operate the Reston service.

FINDINGS AND IMPLICATIONS

The RCB operation has achieved increases in coverage and experienced reductions in travel time. Average travel times for Reston residents riding the RCB decreased about 20 minutes over the analogous bus travel times prior to the July 1973 opening of the preferential access ramps. In addition, because of preferential lane treatment and left-turn privileges within Washington, D.C., the RCB now averages approximately 60 minutes for the trip to Reston. This compares favorably with an average auto commuting time of 50-60 minutes for the same trips.

Transit coverage has been dramatically increased through the initial collection system within Reston which permits buses to follow specific routes, picking up passengers who transfer at the Dulles access ramps for express line-haul and distribution service. This system is contrasted with the original bus service which traversed only main streets in Reston and then proceeded directly on Routes 7, 123, and the GW Parkway towards the Washington, D.C. destinations on a rigid fixed-route system. RCB system management can adjust internal Reston pick-up routes to be responsive to changing passenger demands.

High transit vehicle productivities for this type of service, 25 to 30 passengers per in-service vehicle-hour, have been achieved because of a fairly high residential demand density for trips to a major employment center. People are attracted to the service because of the high level of service offered, i.e., routes and schedules responsive to demand, express service, and buses equipped with air conditioning and reclining seats. People are willing to pay the relatively high fares because these fares are perceived to be lower than the alternative costs of taking these rather long trips--18 miles and more--by auto.

Ridership

Ridership has grown dramatically during the first eight years of RCB service. Monthly patronage in March 1968 was just over 1,000; by 1974 it was as high as 47,000 and in January of 1976 it reached almost 50,000. To a great extent, this growth is related to the increase in Reston's population (Figure J-4).

System Revenue and Expenses

RCB has been managed such that revenues cover operating costs. Additional runs are not scheduled until existing patronage warrants their introduction. The organization is also in a favorable cash flow situation; most riders pay in advance for express bus services, while invoices from the carrier follow delivery of services. RCB is a non-profit organization; surpluses one year tend to balance losses incurred in adjacent years.

System costs per passenger trip have risen steadily, primarily due to increased costs for the contracted transportation services. For the RCB fiscal years ending February 1974, 1975, and 1976, these costs were $1.12, $1.50, and $1.62 per passenger trip. These rising costs were a primary factor in shifting from the WMATA to the Colonial Transit Company. The full impact of the reduced contracted cost per bus trip (from WMATA's $66.91 to the Colonial's $41.00), has already been reflected in an improved cash flow and has thrown the corporation back into a surplus position after two consecutive years showing operational losses.[1]

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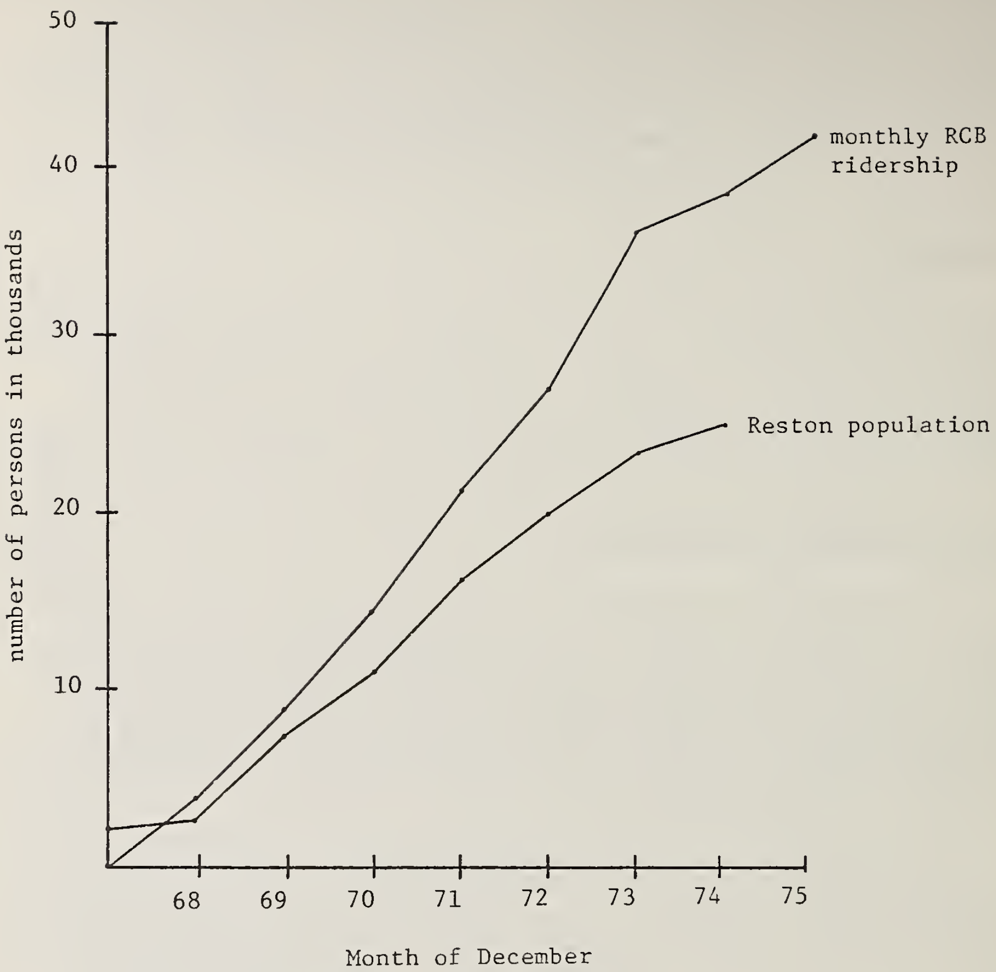
[1] The cost difference is not quite as dramatic as these numbers indicate. Colonial buses have a seating capacity of only 41 passengers compared to 51 for WMATA buses. Realistically, the contracted cost dropped from $1.31 per bus seat for WMATA service to $1.00 per bus seat for Colonial service.



Sources: "Historical Documentation of the Reston Commuter Bus," Commonwealth Research Corporation, Reston, Virginia, February 1976; and, "Annual Report, Reston Commuter Bus, Inc.," February 1976.

FIGURE J-4. COMPARISON OF RESTON POPULATION TO MONTHLY RCB RIDERSHIP IN MONTH OF DECEMBER, 1968 - 1975

The contracted transportation costs for the past three RCB fiscal years, constitute approximately 95% of system expenses.

RCB has received no Federal or State subsidies. It did receive temporary financial assistance from Fairfax County, Virginia, when WMATA instituted a pricing policy incompatible with RCB system management. RCB felt that, without assistance, fares would have to be raised to the point that ridership would decline severely, thus eroding the system's financial integrity and popularity. County subsidies were curtailed when RCB cancelled its contract with WMATA and entered a contract with Colonial Transit.

User Attitudes and Characteristics

In a survey of RCB clients it was learned that system users place a high priority on comfort and convenience. The survey also indicated that, even if fuel prices were to return to pre-energy shortage levels, riders would continue to use the RCB. Median family incomes and numbers of private automobiles per household are high among Reston residents. Therefore, travel costs may tend less to influence their decisions. The convenience of the service is assumed to be a major factor in their expressed preference for the RCB bus service.

Local Considerations

RCB's service area characteristics play an important role in ultimate system analysis. On the one hand, transit patronage seems unusually high for primarily white-collar, higher-income individuals usually pre-disposed against public transit. On the other hand, a high percentage of ridership is composed of Federal employees, who might be more positive toward participation in public programs. In any case, Reston, as a community, appears to attract individuals with higher than average motivation and public spirit.

Reston's geographic situation may have serious implications as well. The city is isolated, with highly defined borders and most housing grouped in clusters. Thus there may be an unusual level of physical identity with community among Reston citizens.

Furthermore, Restonians are denied automobile access to the Dulles Airport Access Road, which would otherwise

provide a convenient, direct and considerably faster route to Washington area employment centers. The RCB buses have enjoyed access to this highway for several years and, as passenger locations have tended to become more uniformly distributed throughout the community, bus travel times have been reduced by almost 25% (from approximately 80 minutes to 60 minutes on the average) and are now fairly consistent with average private auto travel times ranging from 50 to 60 minutes to the same destinations.

Institutional Factors

Use of private sector carriers for this community-based bus service appears to RCB at this time to be preferable to use of transit authority service, mainly due to savings allowed by part-time labor. Though RCB administrators deem the switch to a private carrier to have been crucial to RCB's survival, Colonial Transit initially harbored some reservations: driver turnover was unusually high in the Reston area, possibly because of a limited number of willing local bus drivers; all maintenance other than routine functions must be performed at considerable distance from Reston; and, according to Colonial administrators, the profit from Reston operations has been less than anticipated.

Finally, it is possible for a community with highly motivated residents to overcome existing laws and institutional constraints, which have tended to favor public transit, through the time-consuming, but effective, process of open and public hearings and negotiations.

REFERENCES

1. CACI, Inc. - Federal, A Report to the Transportation Systems Center, "Evolution of Reston Commuter Bus," September 1976.

2. Commonwealth Research Corporation, Reston, Virginia, "Historical Documentation of the Reston Commuter Bus," February 1976.

3. "Annual Report, 1975, Year of Transition, Reston Commuter Bus, Inc.," February, 1976.

APPENDIX K

EVOLUTION OF THE COM-BUS SYSTEM

OVERVIEW

Southern California Commuter Bus Service, Inc. is a privately-owned, profit-oriented, non-subsidized commuter bus system operating in the Los Angeles, California, metropolitan area. The system encompasses three subsidiaries: (1) COM-Bus, a "passenger stage corporation," that handles commuter bus services; (2) an equipment division that owns and leases both buses and minibuses; and (3) TransUrban Associated, a research and informational arm. This review focuses on the COM-Bus operation.

The system began in 1968 on an informal basis when a major employment center transferred many employees to a new facility about 40 miles from its original location. Since then, COM-Bus has grown to be a sophisticated, multi-modal operation, carrying approximately 2,000 commuters per day on 47 routes.

COM-Bus has received no federal funding and its service is independent of UMTA's SMD Program. The manner in which COM-Bus evolved may be applicable to other locations. Hence, its background and operational procedures are being analyzed and documented for dissemination to other communities through the SMD Program.

OBJECTIVES AND EVALUATION ISSUES

The SMD objective to increase transit coverage is germane to COM-Bus operations. Transit coverage has been increased by supplementary services provided by two public transit agencies in the COM-Bus service area, the Southern California Rapid Transit District (SCRTD) and the Orange County Transit District (OCTD). One-way trips of 22 to 56 miles one-way involving intra- and inter-system transfers and up to several hours travel make SCRTD and OCTD normal route services inappropriate for regular commuting. COM-Bus has provided a viable alternative to the private automobile for such trips, since nearly all COM-Bus riders previously drove their own cars to work.

Also relevant to COM-Bus operations is the SMD objective to increase transit vehicle productivity.

Increased vehicle productivity is manifested in the high ridership generated for trips where the only other alternative is the use of the private automobile. Moreover, by effectively matching supply and demand, COM-Bus has been generating profits in an era where most transit operations are heavily subsidized.

Institutional and regulatory considerations have been major issues in the COM-Bus system's development. COM-Bus is a "passenger stage corporation," required to clear all regular routes between fixed terminals with the California Public Utilities Commission (PUC), and is essentially considered a public utility.

Another issue of national interest is COM-Bus' profit orientation. The system is able to end fiscal years with profits in an era of heavily subsidized transit operations.

Operational rules and the reaons behind their adoption constitute another issue. The COM-Bus system is managed by a small, part-time staff. Functions such as fare collection, passenger surveys, and route/schedule adherence are administered by bus "captains" and "route coordinators." (In return for their services, bus captains ride the system free.) Captains may at the same time be perceived as passenger representatives to system management and management representatives to passengers, necessitating strictly defined rules of conduct.

SERVICE DESCRIPTION

COM-Bus operates in the Los Angeles metropolitan area. Routes cover the San Fernando Valley (northwest of the Los Angeles CBD) and coastal sections of Los Angeles and Orange Counties (see Figure K-1). Coastal regions have experienced tremendous growth in the last decade both in residential and employment center development. Most COM-Bus routes originate in the northern and southern sections of its service area at key locations in the San Fernando Valley, Santa Monica, and Orange County areas.

COM-Bus service generally comprises a few-to-one transportation service. Most users drive or are driven to pickup points selected on the basis of their proximity to users' residences, proximity to freeways, and parking provisions. Buses may stop at a few pickup points before embarking on the line-haul portion of their trips. Nearly all COM-Bus routes use the San Diego Freeway (I-405), the primary artery running in a northwest-southeast direction

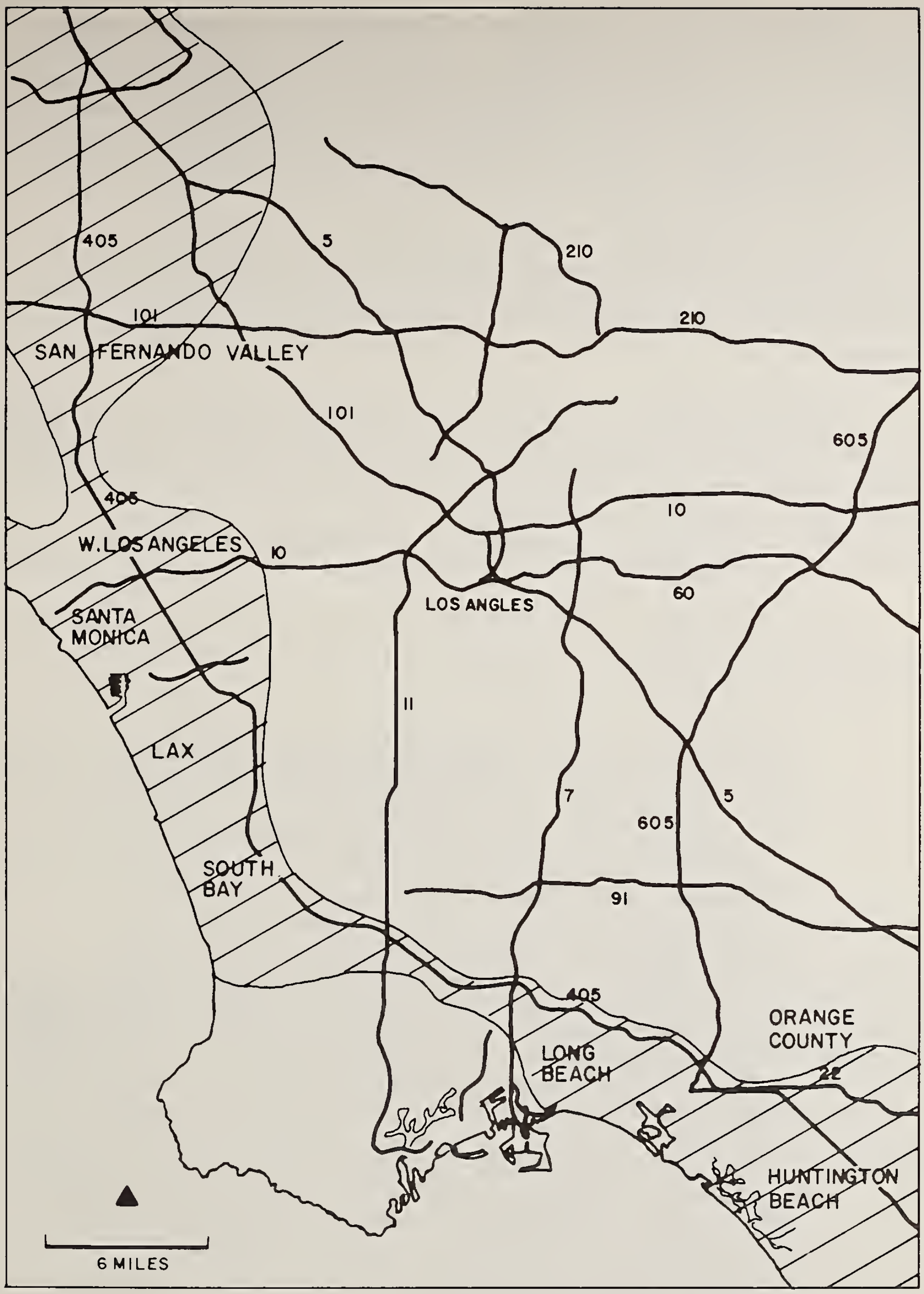


FIGURE K-1. COM-BUS SERVICE AREA

from the San Fernando Valley to the Orange County coast. Passengers are dropped off at employment center entrances. Currently, service is provided to 12 employment centers, most in the Los Angeles International Airport and South Bay Industrial Park areas. Travel times range from about 30 to 75 minutes. The morning commuting sequence is reversed in the afternoon.

Buses presently receive no preferential treatment. However, a special bus/carpool lane has been slotted for implementation on sections of the northbound San Diego Freeway, with a potential favorable impact on COM-Bus travel times.

COM-Bus solicits ridership through a marketing program aimed at employment centers, and exposure techniques such as bumper stickers. In addition, COM-Bus provides marketing information to major employment centers which are not currently served by the system. At present, system expansion is not a high priority, according to the company's president, Ron Hoffman.

New routes are implemented only after adequate demand has been demonstrated. Equipment comes from a variety of sources:

1) Buses and professional drivers are obtained on a per-route basis under contracts with local charter bus companies. Vehicle capacities range from 38 to 47 passengers. Since COM-Bus contracts with suppliers on a route-by-route basis, those vehicles with higher capacities generally prove to be more profitable than those with lower capacities. Buses are equipped with air conditioning, reclining seats, music, and refreshment bars (used only for afternoon trips). The cost for a bus and driver ranges from $80 to $100 per round trip, based on market conditions as well as equipment and route length. COM-Bus has contracted simultaneously with as many as eight carriers; it presently contracts with five.

2) Southern California Commuter Bus Service, Inc.'s equipment division currently owns four buses. In the past, it operated these buses with staff drivers, but now the buses are leased to individuals who agree to provide COM-Bus services during commuting hours.

3) Eight minibuses are currently owned by the equipment division. Though they do not contribute much to the system's profitability, they accept overflow patronage, as well as allow routes to be continued despite drops in patronage (i.e., a bus running only half full could be replaced by one or two minibuses, rather than have service be curtailed on that route). Minibuses are specially converted vans that provide amenity levels similar to full-size commuter buses. Users operate the minibuses and obtain minor maintenance services wherever convenient; major services are performed at outlets with which COM-Bus has contracted.

Fares vary from $13.75 to $15.50 per week, in proportion to one-way trip length (22 to 65 miles). Riders purchase bus seats by the week; only under special circumstances may "no show" days be credited to a rider's COM-Bus account.

According to the company president, COM-Bus user characteristics are apprxoimately as follows:

male	70%
female	30%
white collar and professionally employed	60%
blue collar employed	40%
average annual gross income	$22,000

COM-Bus employs a full-time clerical staff of two persons. The company president provides considerable administrative input after working hours. In addition to bus captains on each route who are responsible for selling weekly tickets, enforcing rules, and other clerical functions in return for free system use, there are four part-time, salaried "area coordinators." Area coordinators collect revenue from bus captains, provide accounting functions, and act as liaisons between COM-Bus administration and bus captains--and, through bus captains, with passengers.

HISTORY

The individuals originally associated with COM-Bus were employees of the McDonnell Douglas Astronautics Company. In 1968, the company transferred many of its employees from its Santa Monica facility to a new headquarters in Huntington Beach, approximately 40 miles southeast. Since many employees already lived a considerable distance from the original plant (popular residential locations tended to be north and west of the older facility), transfers posed alternatives of excessive daily car commuting times (with attendant costs) or residential relocation. The company undertook a survey to determine interest in establishing a company bus system, but the notion was scrapped on the basis of legal uncertainties. The organization of a commuter bus system for McDonnell Douglas employees affected by the transfers fell into the hands of a group of 45 employees; they sought and obtained bids from several local charter bus companies, of which one was selected. The popularity of this first bus proved to be a catalyst for others to be implemented by similar commuter groups.

During this organizational development phase, Ron Hoffman, an informal leader/spokesperson (employed at McDonnell) was selected. Knowledge of PUC regulations with bearing on commuter bus operations gradually was accumulated, causing several changes in system organization, heavy time expenditures among participants, and changes in carriers. The need for a route/passenger coordinator became apparent to the company providing charter bus service to McDonnell Douglas. The position was offered to Hoffman, but, instead of acting as a representative of the charter bus company, he decided to set up his own enterprise (COM-Bus) to handle all clerical, financial, and route selection functions (including dealing with the PUC). Thus, what were initially five independent commuter bus operations serving McDonnell Douglas jelled into one organization in an attempt to consolidate contractual obligations and expedite operations.

In the period following this consolidation and the establishment of COM-Bus under its present name, a series of legal battles ensued. Some concerned the right to duplicate routes already claimed to be served by the Southern California Rapid Transit District (SCRTD); interpretation of PUC regulations--both in intent and in letter--were topics of discussion and litigation with the SCRTD. Other battles involved attempts to sever relations with carriers due to apparently inadequate services; problems were encountered with carriers in that their operations tended to be only

marginally profitable, with resultant deterioration in service over time.

In the midst of these controversies, the COM-Bus system was expanding. New, more specialized routes were established, in part through the cooperation of local PUC staffers. COM-Bus experimented with an origin/destination computer program developed by the Federal Highway Administration in order to maximize service to its clients; results of the program were not significantly different from "seat-of-the-pants" observations, and further use of the program was curtailed.

COM-Bus also gained experience in dealing with charter bus companies, selecting those with vehicle fleets that maximized seating capacity. In order to accommodate fluctuations in demand, minibuses were introduced to the system.

FINDINGS AND IMPLICATIONS

COM-Bus seems to have satisfied the SMD objective related to increased transit coverage and increased transit vehicle productivity. The COM-Bus system provides service that is far more specialized to the needs of its clients than public transit service offers. Travel times for COM-Bus passengers are competitive with auto travel times, entailing only the extra time required for collection, boarding, and a minimum number of pre-line-haul stops (if any) and some concession in the form of reduced travel flexibility.

High transit vehicle productivities for this type of service, about 30 to 35 passengers per in-service vehicle-hour, have been achieved because of a fairly high residential demand density for trips to major employment centers. People are attracted to the service because of the high level of service offered, i.e., routes responsive to demand, express service, and buses equipped with air conditioning and reclining seats. People are willing to pay the relatively high fares because these fares are perceived to be lower than the alternative costs of taking these rather long trips--22 to 56 miles--by auto.

Furthermore, as the system has expanded, route specialization has increased. For routes experiencing fluctuations in demand, the minibus alternative has enabled COM-Bus to continue service without incurring losses, maintaining high levels of vehicle loading. To some extent,

Typical Van Used by COM-Bus in Special 14-Passenger Minibus Configuration

this feature of COM-Bus service has implications on the SMD objective calling for increased vehicle productivity, inasmuch as vehicle assignments are made on the basis of consumer demand.

Ridership

Ridership grew rapidly during the system's first five years of operation. Ridership levels have held fairly steady since 1973. This is due to Ron Hoffman's desire to maintain the existing size of COM-Bus operations, rather than expand the system to the point that administrative responsibilities might intrude on his full-time employment. Key ridership data are presented for 1969 through 1976 in Figure K-2.

System Revenue and Expenses

COM-Bus has managed to operate in the black, in contrast to most public transit systems. This is due to a number of factors, including:

1) contracts with riders on a per-week, rather than per-ride basis;

2) use of riders (bus captains) for clerical functions, compensating their efforts with free system use; and

3) ability to contract with several charter bus companies for varying lengths of time, thus taking advantage of free-market competition and ensuring system adaptability.

System gross revenues for the last few years are depicted in Figure K-2. Fares have risen in response to increasing costs. The extremes of the weekly fare scale (ten one-way trips) are depicted below:

	1968	1975	1976
lowest	$ 8.75	$11.50	$13.75
highest	11.50	13.75	15.50

	69[1]	70[1]	71[1]	72[1]	73[2]	74	75	(est.) 76
average number of routes	1	5	15	30	47	45	47	47
annual passenger trips x 1,000	20	100	300	600	702	690	702	700
annual vehicle miles x 1,000	20	100	300	600	705	695	703	710
annual passenger miles x 1 million	0.8	4.0	11.5	22.0	26.8	27.8	27.0	26.3
average load factor (%)	91	90	91	90	92	93	94	91
approximate gross revenue x $1,000[3]	n/a	n/a	n/a	n/a	n/a	815	850	960

[1] Data for 1969 through 1972 has been estimated by COM-BUS administration. COM-BUS during that period was not a "passenger stage corporation" and was neither recording data rigorously nor reporting data to PUC.

[2] Minibuses were introduced to the COM-BUS system in 1973, with some impacts on average vehicle capacity (reduced). Therefore, load factor and number of routes may be biased upward somewhat.

[3] Accurate data regarding revenues for 1969 through 1973 unavailable at this time.

FIGURE K-2. COM-BUS OPERATIONAL DATA

COM-Bus has received no federal, state, or local subsidies.

System Operations

As ridership has grown, new routes have been implemented. In response to the number of buses bound for one employment center, each route can be more highly specialized, thus minimizing the passenger collection sequence in the morning and the passenger distribution sequence in the afternoon, with favorable impacts on travel time. The number of bus routes and vehicle miles per year are depicted in Figure K-2.

REFERENCES

1. Hoffman, Ronald J., Final Report Draft, The COM-BUS Commuter Bus System, August 20, 1976.

2. Interviews with Ronald J. Hoffman conducted in July and September 1976.

APPENDIX L

DOUBLE DECK BUS DEMONSTRATION PROJECT

OVERVIEW

The Double Deck Bus Demonstration Project involves the purchase and operation of contemporary double deck buses in New York City and Los Angeles. It is expected that experience in daily revenue service will indicate the operational feasibility of the double deck bus type over a range of United States transit service conditions.

Major considerations are acceptance of the generic double deck vehicle by both the general public and the transit-dependent (especially with regard to convenience and safety), possible route assignment limitations, and economic and service impacts.

Participating under two separate UMTA grants are the New York Metropolitan Transit Authority (MTA), with operations conducted by the New York City Transit Authority and its subsidiary, the Manhattan and Bronx Surface Transit Operating Authority (MABSTOA), and the Southern California Rapid Transit District (SCRTD). UMTA grants were approved late in fiscal year 1974.

The MTA has purchased eight British Leyland "Mancunian" buses, four of which were covered by the UMTA grant. The SCRTD has acquired two German "Neoplan" buses manufactured by Gottlob-Auwater KG, but equipped with hybrid domestic drivetrains. Grants cover vehicle purchase and spare parts costs, but do not include operating expenses or costs associated with data collection.

Double Deck Bus Project Funding

	New York City	Los Angeles
UMTA Project No.	NY-06-0044	CA-06-0069
Grant Recipient	New York Metropolitan Transit Authority (MTA)	So. California Rapid Transit District (SCRTD)
Federal Share	$415,984	$334,375

British Leyland "Mancunian" Double Deck Buses to be used by the New York City Transit Authority

Neoplan Double Deck Buses to be used by the Southern California Rapid Transit District

The project is to run three years, ending in June 1977. The first year was originally slotted for vehicle selection, delivery, and set-up ("pre-implementation" phase); revenue service was to comprise the next two years ("implementation" phase). Though the demonstration project is in its third year, activities in Los Angeles have only recently stabilized, with both double deck buses having begun revenue service in June 1976. Modifications required by U.S. safety regulations delayed the arrival of the Leyland buses until August 1976. The eight buses went into revenue service on New York City streets on September 15, 1976.

OBJECTIVES AND EVALUATION ISSUES

The Double Deck Bus Demonstration Project addresses the Service and Methods Demonstration (SMD) Program objective of increased vehicle productivity. Increased productivity is expected to be a result of the double deck buses' theoretical capability to provide higher passenger capacities than conventional buses without schedule change, additional personnel, or otherwise greater expense.

Analytical comparisons of the following criteria will be drawn between the double deck and conventional buses:

(1) operating cost in relationship to vehicle capacity;

(2) compatibility and reliabiliity of service;

(3) passenger safety;

(4) crime and vandalism;

(5) user (passenger) perceptions of accommodations and convenience; and

(6) ease of use by the elderly and handicapped.

These criteria will be examined on a comparative basis within the framework of existing transit systems and conventional full-size buses.

"Before" and "after" comparisons are not specifically required in the evaluation of this demonstration project, since performance of the conventional bus provides a continuous reference against which the performance of the double deck bus can be assessed. Also, there will be no explicit comparison between double deck bus types; however,

in cases where design differences among the manufacturers being evaluated influence quantitative evaluation, these differences will be noted.

PROJECT DESCRIPTION

Double deck buses have been substituted for conventional buses on selected existing routes at both sites. Routes were chosen for their high ridership--conceivably high enough to frequently exceed conventional bus capacity--and the wide range of conditions.

Novel features of the double deck bus include its internal stairway (with safety and circulation implications), unattended second level (though a periscope should allow the driver to monitor the second level on the New York buses), and unusually low first-level decks (just above curb height--admittedly vehicle-specific, but fairly representative of contemporary European transit vehicles). Selected double deck vehicle specifications, along with those for a standard Flxible, are presented in Table L-1.

Double deck buses pose some routing and operational considerations: higher passenger numbers may require proportionally greater attention to passenger movements; routes must also be chosen with moderate street "crowns" and no overhead obstructions, such as low-lying branches, traffic lights, overpasses, etc.

Evaluation of this project is assessing the potential impacts of these and other considerations on normal transit operations. If the increased capacity of double deck buses is found to come at relatively low cost in terms of inconvenience, disruption, and operational expense, then double deck buses may be appropriate for certain United States transit applications.

Site Characteristics

New York City double deck buses are providing service on two Manhattan routes characterized by congested traffic, heavy passenger loads, frequent stops, and frequent passenger turnover (Figure L-1). These routes traverse a wide variety of Manhattan neighborhoods. The buses are operating in regular revenue service, replacing the conventional buses normally assigned those runs.

TABLE L-1. SELECTED DOUBLE DECK VEHICLE SPECIFICATIONS

	British Leyland New York	Neoplan Los Angeles	Flxible NY/LA
Passenger Capacity			
Seated - upper level	43	57	--
Seated - lower level	25	27	47
Seated - total	68	84	47
Length (feet)	33.3	39.3	40.0
Width (feet)	8.3	8.5	8.5
Height (feet)	14.5	14.0	10.0
Wheelbase (feet)	18.5	22.5	23.8
Cost	$83,000	$125,000	$52,000

Source: Service and Methods Demonstration Program Annual Report, U.S. Department of Transportation, November, 1975, p. 187 and conversation with Bass Dyer, Rohr-Flxible, Inc.

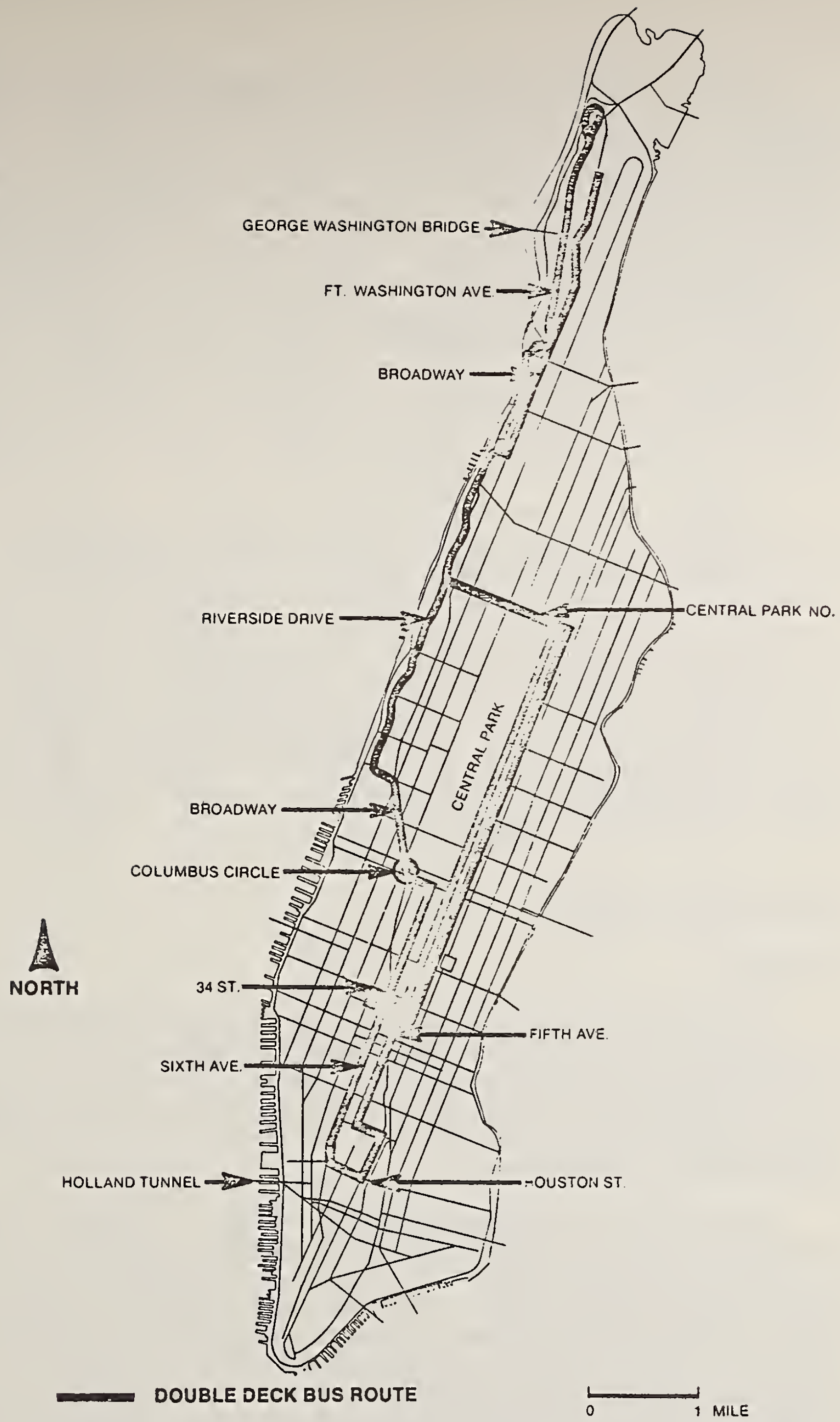


FIGURE L-1. MANHATTAN DOUBLE DECK BUS ROUTES

Double deck vehicles in Los Angeles operate during the principal portion of their runs on the El Monte Busway, an exclusive bus lane extending from the Los Angeles Central Business District (CBD) to El Monte, a suburban community approximately thirteen miles east of the CBD; express freeway service extends to Pomona, about twenty miles further east (Figure L-2). This route is patronized largely by middle-income suburban commuters and is characterized by uncongested traffic conditions, high average speeds, infrequent passenger turnover, and a high level of passenger amenities. If operationally feasible, the vehicles will subsequently be deployed to different routes so as to allow a test of this vehicle under varying traffic conditions and assess its suitability in different types of service.

Double deck bus performance is being compared with that of conventional buses under controlled operations. In both New York and Los Angeles, companion conventional buses (Flxibles at both project sites) will offer opportunities for continuous data comparison. In addition to assessment of double deck bus features, assessments are being made of the extent to which the double deck buses match the reliability level of conventional buses by closely monitoring service and maintenance records. However, it is not the intention of this project to ascribe the reliability levels attained by these particular double deck buses to double deck buses as a class.

HISTORY AND STATUS

New York

Delivery from England of the eight British Leyland vehicles was originally expected in December 1975 but was not completed until August 18, 1976. Some of this delay was due to obtaining emissions certification and performing modifications for conformance to United States safety and operational standards.

The Double Deck Bus Demonstration Project is somewhat unusual in that preparation activities place a high emphasis on route modifications, as well as on typical transit-related considerations. In New York City, the routes on which the British Leyland vehicles will run have been examined, with modifications performed to allow for the 14.5 foot bus height (plus suspension and rebound allowance) including tree trimming and traffic light elevation. In addition, a ground delivery route from the port of entry in

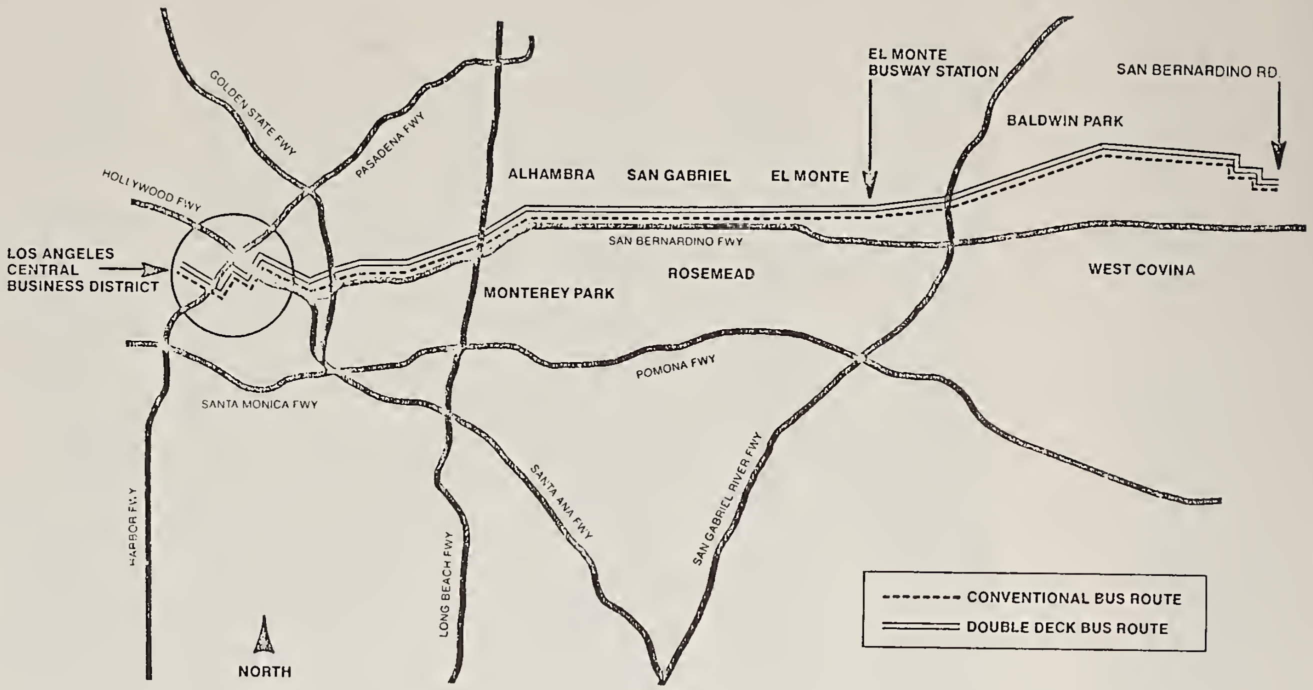


FIGURE L-2. LOS ANGELES DOUBLE DECK BUS ROUTE THROUGH SPRING 1976

Newark, New Jersey, across the George Washington Bridge, to the MABSTOA facilities in Harlem had been specified.

Since the buses ordered are standard production line vehicles (the few special features include left-hand drives, pollution-control devices, and USA safety standard windows), little in the way of post-delivery modifications or adjustments was necessary. In accordance with its initial scheduling stipulations, MABSTOA allowed for an approximate one-month pre-revenue service set-up and training period. Revenue service was introduced on Manhattan streets on September 15, 1976.

Los Angeles

The Los Angeles double deck bus project tentatively achieved full operational status in June 1976. For the previous six months, both double deck buses had been idled by a steering system defect.

The first of the two double deck buses (Neoplan #9900) arrived on the East Coast in December 1974 and was exhibited in several cities en route to Los Angeles. The second double deck bus (Neoplan #9901) arrived in Los Angeles in June 1975.

The Los Angeles double deck buses were precluded from initiating route service within a reasonable period of delivery due to a combination of certification and equipment-related setbacks. Certification problems were encountered in obtaining approved exterior lights, while equipment-related setbacks included delivery and installation of differentials having higher numerical ratio (for urban, rather than highway use), and speedometer adaptors for the modified differential gearing. In addition, automatic transmissions were retrofitted with optimum speed gear-changing components. Revenue service began for Neoplan #9900 in April 1975, but this service was riddled with interruptions (the causes are described in a later section). Neoplan #9901 commenced revenue service in late May 1976. The companion Flxible buses (Flxibles #7300 and 7301) started service at the same time as Neoplan #9900 and have experienced no major problems to date.

Fewer physical route modifications (e.g., tree trimming, raising traffic lights, etc.) were required than in New York. However, the route alignment has undergone "fine-tunings" in response to a newly implemented transit "grid" system. The main impact of these fine-tunings is

greater route length (to Pomona, rather than Covina) with a higher proportion of freeway travel.

Impact of Project Delays

Originally, data on user response were to be collected in New York on two occasions, approximately one year apart (spring 1976 and spring 1977), to eliminate possible seasonal bias. Due to delays, the first data collection occurred in fall 1976. Data on user response in Los Angeles was collected once, in fall 1976.

FINDINGS

Some preliminary results related to objectives and assessment of project impacts are now available. These include service and repair records in Los Angeles and New York, pre-delivery institutional findings in New York, and interview responses of passengers at both sites.

Los Angeles and New York Service and Repair Records

Following vehicle certification in Los Angeles, operational problems have befallen Neoplan double deck buses, causing frequent and lengthy interruptions in route service for Neoplan #9900 and, up to very recently, precluding initiation of revenue service for Neoplan #9901. Problems can generally be categorized along three lines:

Operational Problem Category	#9900	#9901
(1) Quality control-related		
a. transmission defects	X	X
b. speedometer inaccuracy/ malfunction	X	X
c. air conditioning and miscellaneous malfunctions	X	X
(2) Maintenance-related		
a. premature brake lining wear out	X	
(3) Safety-related		
a. steering system "bell crank" failure	X	X

The conventional bus (Flxible #7300) designated as the companion vehicle for Neoplan #9900, along with many vehicles in the SCRTD's Flxible fleet, has been affected by industry-wide deficiencies in its "121" brake system; however, this problem has had no significant impact on route service.

As of April 1976, Flxible #7300 had accumulated about triple the route mileage (approximately 70,000, as compared with approximately 24,000 miles) of Neoplan #9900; both initiated route service at the same time.

A severed "bell crank" in the 9900's steering system (a very serious and potentially dangerous failure that has safety-related implications for all Neoplans so equipped) put both double deck buses out of service from mid-December 1975 through late May 1976. The length of interruption in service may be partly attributable to difficulties involved with overseas communication.

Maintenance and quality control-related problems have incapacitated the Los Angeles double deck buses for inordinate amounts of time. For example, brake relining on a conventional bus is typically a routine half-day maintenance procedure that is seldom required more often than every 12,000 miles. However, on Neoplan #9900, brake relining is required much more frequently. Early experience indicates that lining life is less than 8,000 miles,

possibly due to double deck bus weight. Brake relining has detained the bus for up to three days.

Proper air conditioning performance is essential for both Neoplans and Flxibles, as both models are equipped with non-operable windows. While the Flxibles' air conditioning system has proven to be reliable, the Neoplans' system, requiring a separate engine for each deck, caused problems in early months which temporarily interrupted revenue service. It appears that these problems have been alleviated.

In New York, problems were encountered with the air conditioning and heating systems, causing the buses to be taken out of service on extremely hot and cold days. Leyland engineers have been working to alleviate these problems.

New York Pre-Delivery Institutional Considerations

In gearing up for double deck bus delivery, MABSTOA discovered that its 125th Street depot, from which buses using the routes in question are dispatched, lacked sufficient clearance for double deck vehicles. Therefore, double deck buses will be stored at another Harlem depot, but dispatched from the 125th Street depot. This use of dual facilities will involve some shuttling for operators, but possible union-related difficulties have been averted.

The transit union has expressed some concern with regard to double deck bus operators' levels of compensation, pointing out that double deck buses may require more skill and attention to operate than conventional buses. Since this remains to be seen over the course of the demonstration project, the union has agreed not to demand additional compensation for drivers for the duration of the demonstration.

Passenger Response

Passenger response has been very favorable towards the double deck buses. In a series of interviews the proportion of people preferring the dcuble deck bus was several times as large as the proportion preferring the conventional bus. This held true for the handicapped and elderly patrons as well. Persons making short as well as long trips utilized the upper level.

IMPLICATIONS

It is evident that a variety of factors not directly associated with double deck bus performance has had a significant and limiting impact on the demonstration project's data output. These factors tend to be exogenous, rather than site-specific, such as delays in delivery and necessary modifications to European vehicles.

In Los Angeles, it appears that operational problems have been largely due to the mating of parts from several manufacturers. The Neoplans currently running are, in essence, prototype vehicles. While it is hoped that their reliability factor will be much higher than in the past, the application of a prototype vehicle should ideally be preceded by ample testing, as in UMTA vehicle development programs.

In both cases, trans-Atlantic communication has been less than ideal. But double deck bus use in urban American situations remains as valid a concept as when the project was approved, especially when viewed from the perspective of passenger response.

REFERENCES

1. CACI, Inc., "An Evaluation Plan for the Double Deck Bus Demonstration Project," November 1975.

2. U.S. Department of Transportation, Transportation Systems Center, "Double Deck Bus Project Evaluation Plan," Working Paper No. WP-230-C.3-44, October 24, 1974.

APPENDIX M

DANVILLE TAXI USER-SIDE SUBSIDY PROJECT

OVERVIEW

The Danville, Illinois Taxi-Discount Demonstration Project (IL-06-0034) is a user-side subsidy test in which special groups are provided with fare discounts on a shared-ride taxi service. The special transit-dependent groups being served now are the elderly and the handicapped of all ages. "User-side subsidy" means that the user of the taxi service is subsidized rather than having the government directly subsidizing the transportation operator. The participants are certified as eligible for the service, are issued identification cards, and use taxi service in the usual way; however, they pay only a discounted amount (25-30%) of the fare with the remainder of the standard fare recorded against their identification number on a "charge slip" which is used to reimburse the taxi operator out of project funds. There is a monthly limit on the amount of total fares on which a person can receive discounts.

Funding and Sources

UMTA (FY75)	$314,530
Other Federal	0
State	0
Local	34,024
Total	$348,554

Timing

Date of Grant Award:	7/07/75
Demonstration Start Date:	11/10/75
Planned Termination Date:	8/31/77

The project includes a 3-month planning phase and a 21-month demonstration/ridership phase.

OBJECTIVES AND EVALUATION ISSUES

The Danville User-Side Subsidy, Taxi-Discount Demonstration Project directly serves the SMD Program objective: to improve service for transit-dependent persons--in this case, the elderly and handicapped.

Locally, the City of Danville will be assessing the demonstration in terms of how much it would cost them to finance some form of the Reduced Taxi Rates Program (as it is locally referred to) after the demonstration. At present, such service for the handicapped and elderly (or some submarkets of those groups) is being analyzed as a possible component of an overall city-wide public transit service.

In addition to testing the user-side subsidy concept, this demonstration is one step in the direction of designing and testing what has become known as "flexible" services, whereby various markets for transit services can be supplied by local private transportation suppliers.

In a national perspective, this project is undertaken at a time when Federal law (Urban Mass Transportation Act of 1964, as amended, Section 16B) requires that public transportation be accessible to elderly and handicapped persons. One prevalent response to these requirements in small towns is the implementation of a dial-a-ride system, a door-to-door bus system with moderately high costs per passenger trip. This project tests the cost-effectiveness of an alternative approach involving the use of privately operated shared-ride taxi service. Thus, the project provides an opportunity for assessment of taxi-transit coverage, travel time, reliability, and vehicle productivity--all of which may be compared to dial-a-ride or conventional transit characteristics in small communities. Moreover, one of the most important comparisons, subsidy cost per passenger trip, will determine the cost-effectiveness of taxi-transit service in supplying door-to-door transit service.

The key issues to be examined are:

- Impact of service to transit-dependent
- Impact of mobility of transit-dependent
- Mode shift from other modes to project mode with subsidy

- Accessibility of taxi service to transportationally handicapped
- Taxi vehicle and labor productivity
- Impacts on taxi operations
- Impacts on social service agencies
- Project costs and administrative effectiveness
- Instances of or potential for fraud
- Impact on institutions involved and public opinion

PROJECT DESCRIPTION

All Danville residents who are either handicapped or 65 years of age or older are eligible for the Reduced Taxi Rates program which provides a discount on the cost of taxi rides. The discount applies to any rides in or around the City of Danville. Those having Taxi Discount Identification Cards are able to use a taxi whenever they want, showing their ID card, paying for their share (a round-numbered amount) with cash and charging the remainder to the project on a specially designed charge slip, which is available in the taxi. Both the user's ID number and signature are required on the charge slip, a copy of which is given to the user. The remaining charge slip copies are then turned in by the drivers to the taxi operators, who redeem them for cost from the City.

The Danville taxi fare structure is zone-based with four zones covering the whole of the city; there are additional charges for mileage beyond the city limits and various extra service items. All items of service, other than tips to the driver, are covered by the discount policy. Tips are at the discretion of the user and are paid in full by the user.

The full fare, discounted fare, subsidy amount, and discount rate for each zone and service item are presented below:

Elderly and Handicapped Shared-Ride Taxi
at a Reduced Rate, Danville, Illinois

Service Item	Full Fare	Discounted Fare	Subsidy Amount	Percent Discount
Zone 1	$.75	$.25	$.50	66.7
Zone 2	1.25	.30	.95	76.0
Zone 3	1.50	.40	1.10	73.3
Zone 4	1.75	.50	1.25	71.4
Extra Miles	.40/mi.	.10/mi.	.30/mi.	75.0
Extra Riders over 1	.15/ea.	.05/ea.	.10/ea.	66.7
Packages over 2	.10/ea.	.05/ea.	.05/ea.	50.0
Waiting Time	6.00/hr.	1.50/hr.	4.50/hr.	75.0
Deliveries	.25 + fare	(25%)	(75%)	75.0

The fare charged is for the higher priced zone, whether it is the zone of origin or the zone of destination. Any trip beginning and ending within a zone is charged the fare for that particular zone. In addition, extra fare is charged for service items beyond travel within zones. For instance, extra miles beyond the 4-zone area, packages, and wait time. Group riding allows additional passengers with an additional charge of $.15 per person. There is no charge for additional passengers who are under 12 years of age.

Thus, the zone-based discounted fares range from $.25 to $.50 plus additional charges; the subsidy amount ranges from $.50 to $1.25; and the discount rate ranges from 66% to 76%. There is a limit of $20 worth of rides at face value that can be discounted per person per month; participants agree to this rule when signing up for the program. Computer processing of the charge slips allows monitoring of this limit by individual ID number.

Elderly persons are certified on the basis of age, regardless of whether they are handicapped. Verification of age is possible through the local Social Security office given a permission slip signed by the applicant. Those under 65 who are handicapped are certified on the basis of an Eligibility Criteria which was based on a similar criteria drawn up by the San Francisco Bay Area Task Force on Handicapped Definitions. A one-page form is filled out and signed by a doctor or social service agency counselor. All certification and receipt of identification cards can be done by phone and mail--participants are not required to come into the project office.

With the use of the "charge slip" system, participants do not have to purchase discounted tickets in advance, and

the project office is not burdened by a periodic distribution effort. However, the charge slips are data processed to verify taxi operator bills and to monitor individual use of the project.

Marketing

The project is well advertised in several media including newspapers and radio. It had one week of spot advertising on the radio during the second month of the project. Posters were distributed in the low income areas. The project has received frequent coverage in the news and editorials.

Site Characteristics

The City of Danville, Illinois, is the demonstration project service area. Danville is located approximately 130 miles south of Chicago and 80 miles west of Indianapolis. It has an area of 12.9 square miles and a (1970) population of 42,600 persons.

The breakdown of the 1970 Census population in round numbers by age category and an estimate of the handicapped under 65 years of age is shown in Table M-1.

TABLE M-1

DANVILLE POPULATION BY AGE (1970)

Age Category	Number	Percent (%)
0 - 4	3,300	7
5 - 15	8,800	21
16 - 20	3,700	9
21 - 54	16,900	40
55 - 59	2,200	5
60 - 64	2,100	5
65 and over	5,600	13
	42,600	100
Handicapped under 65[1]	1,900	4.5

[1]Estimate provided by local rehabilitation agency personnel.

The eligible population is thus estimated to be comprised of 5,600 persons 65 and over, plus 1,900 handicapped persons under 65, or 7,500 persons total; this amounts to 17.5% of the total population of Danville. The fraction of the total population that is 65 years of age or older, at 13%, is higher than the national average of 10%.

In 1970, the Danville median family income of $9,658 was not significantly different from either the national median family income of $9,433 or the median family income of $10,020 for the North Central States. Household ownership of automobiles in Danville is the same as for the nation as a whole.

There is no public or private bus-transit service in Danville. However, eleven social service agencies provide some paratransit services to their clients. This amounts to about 3,000 one-way passenger trips per week during school months (i.e., including children in Special Education Programs). This drops to 1,500 trips during the summer. The service is provided on vehicles owned by the agencies and through purchase of transportation services from the local cab companies. The total number of paratransit vehicles operated by the agencies are 8 automobiles or station wagons, 2 vans without lifts and 1 van with a lift.

As a small urban community with no general public transportation service but with shared-ride taxi services provided by several suppliers, Danville was seen as an optimal site for testing both the user-side subsidy concept and the ability of private local suppliers to provide necessary transportation services for the handicapped and elderly.

HISTORY AND STATUS

Background

The taxicab companies in Danville are regulated on a franchise basis by the City Council which approves fare changes and other changes in service. There are no statutory limitations on either the maximum number of vehicles or the number of companies. The cab companies operate in the traditional taxicab mode with calls being handled by a dispatcher and assigned to drivers.

In early 1974, with the beginning of the energy crisis, the cab companies received permission from the City Council to introduce shared-riding. In this case, each ride is

charged the applicable zone fare. The only exception in practice to the rule is that a person is allowed to refuse to share a cab if the other person appears to be intoxicated.

Thus, there is both group riding and shared-riding in Danville. In the former case, two or more persons ride together from the same origin to the same destination. Any multiplicity of origins or destinations causes the rides to be treated as shared rides and separate fares are charged.

The taxicab system consisted of three operators before the demonstration. The largest taxi company operated a total of 20 vehicles, with the number of vehicle trips ranging from 600 to 800 per day. The second largest taxi company operated a total of 10 vehicles with the number of trips averaging 250 on weekdays and Saturdays, and 100 on Sundays. The third cab company operated one cab; recent accidents had taken the other two cabs out of service. Most ridership on the third cab company is prearranged by appointment, averaging 20 passenger trips per day before the demonstration. In all three cases, drivers are paid 40% commission on all fares plus tips, except that the drivers for the largest company are guaranteed a minimum of $1.90 per hour. Peak demand times are 9:00 a.m. to 11:00 a.m. and 1:00 p.m. to 3:00 p.m. on weekdays. Fridays and "check days" at the end and beginning of each month have the highest demand.

Project Evolution

The original grant application for the demonstration was written so that a wide range of age groups, including all persons under 21 and over 54 years of age, and handicapped persons of all ages could be made eligible for the user-side subsidy. This total group amounted to 23,750 persons over five years of age, or approximately 56% of the total population of Danville. Projections for ridership had been made on the basis of Dail-A-Ride and other experiments similar to this one in other parts of the country. A budget for subsidy monies was then determined.

During the planning phase, it was decided that the project should be staged to control for the unknowns in potential demand. Given the ease with which the new service could be used (i.e., taxi service is a known commodity to the public) and the high discount (70 to 75%), it was thought that demand might build up too fast to be adequately handled by the cab companies, the project staff, and the

budget for subsidies. Thus, a priority was set for the system to be first tested for all persons 65 years of age or older and all handicapped persons under 65 years of age.

The other departure from the grant application at the time of implementation was a switch from the use of "taxi tickets" to a "charge slip system" whereby eligible persons would pay their share at the time they take a ride instead of periodically purchasing discounted tickets. This decision was reinforced by the fact that charge slips had been previously used on Danville taxis for welfare and commercial customers, and thus, the taxi drivers were accustomed to the concept. This change was not a change in the concept being tested, but rather an administrative innovation.

The initial announcement-advertisement for the project was placed in the local newspaper on November 9, 1975, with registration beginning the next day (see Figure M-1). In the following February, it was decided that new groups would not be added at that time to those already eligible (i.e., those 65 years of age and older and handicapped persons of all ages).

In April 1976, five months into the demonstration, the second largest cab company discontinued service in Danville, leaving the largest company and the third largest cab company, which operates only one vehicle. This caused an immediate drop in supply of service with the other two cab companies expanding, as possible, to meet the increased demand for their services.

Current Status

The demonstration is proceeding on schedule. All of the transit-dependent are not eligible, as was originally planned. Because the priority for testing youth or lower age limits for the elderly may be less important than testing other innovative transit operations, the following three approaches are being considered for possible future implementation into the Danville demonstration:

- Continue serving the present target groups with the present discount on taxis until such time as it stabilizes into a clear pattern. At that time, change the eligibility requirements (e.g., lower the age limit from 65 to 62) and/or the discount rate (e.g., from 75% to 50%), such that the City of Danville would test a program (at some expected

Now Available in Danville!

If you are 65 or over . . . or handicapped you may qualify!

This zone chart shows what you'll pay for cab rides under this subsidized project.

ZONE NO.	REGULAR RATE	"RTR" RATE
1.	75¢	25¢
2.	$1.25	30¢
3.	1.50	40¢
4.	1.75	50¢

Rides to other areas comparably reduced.

Reduced Taxi Rates

Some things you'll need to know:

1. You MUST live within the City of Danville.

2. Eligible persons may receive rides totaling $20 in face value during any month.

3. Charge slips will be issued at the time of the ride and will be available in all cabs.

4. The City of Danville will provide forms for handicapped persons to become certified.

5. An I.D. card will be required. I.D.'s may be obtained by calling the number below.

"Reduced Taxi Rides" in Danville is a unique test program sponsored by the Federal Government and the City of Danville. If you use the service and it works, it may be continued beyond the initial 21 months. Critical mobility for All who need transit at a Bargain for everbody in the Simplist way

FIGURE M-1. AD FOR REDUCED TAXI RATES

total annual cost) that it would seriously consider continuing on its own, with whatever state and Federal operating subsidies that would be available after the SMD demonstration.

- Design two jitney-type or taxi-cruising routes with expected high demand. Negotiate with the local suppliers (including taxi companies) to provide the service at some lower level than taxi fare cost per passenger trip and establish some subsidy level that would make the service attractive to youth and/or other members of the community and at a level that the city, again, would be interested in continuing after the demonstration.

- Use project staff time to negotiate with taxi operators, employers, and employees regarding the establishment of subscription work trip packages that would be attractive to the suppliers and consumers; no subsidy is contemplated in this case.

FINDINGS

To date, after eight months of registration, 2,600 persons have registered for the project. 2,050 (or 80% of those registered) have used the project at least once, i.e., charged at least one taxi ride using their I.D. numbers. The number of users in any one month has approached 1,300 (or 50% of those registered) during the summer of 1976. Figure M-2 presents the available data on number of persons registered, users-project-to-date (PTD), and users-month-to-date (MTD) for each month of the project.

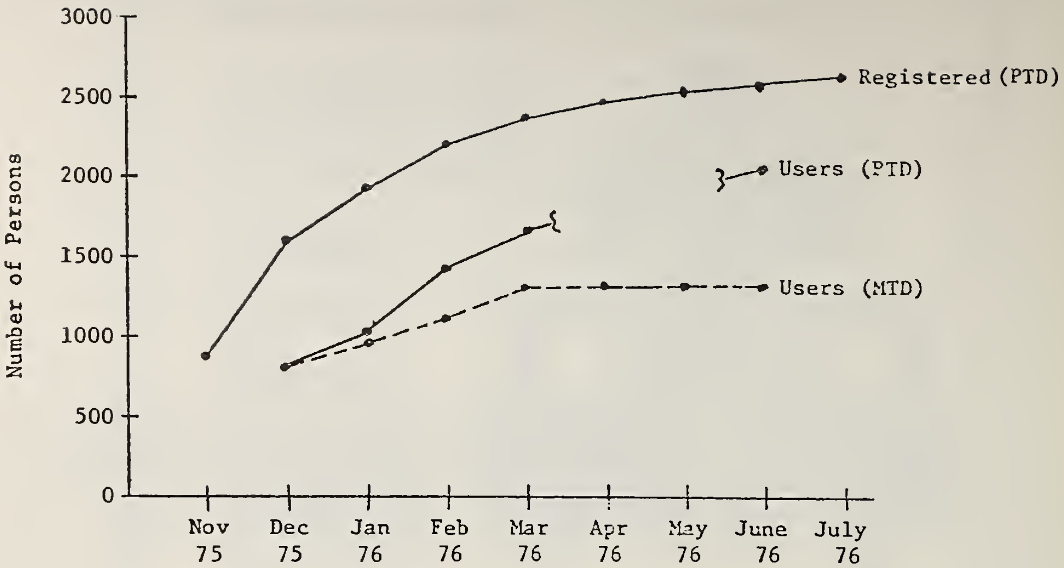


FIGURE M-2. PROJECT REGISTRANTS & USERS
(DANVILLE, ILLINOIS)

The total presently eligible population of elderly and handicapped is estimated to be 7,500 persons or 18% of the total population. After eight months, then, the market penetration is as follows:

- One-third of the eligible population has registered (6% of total population)
- One-fourth of the eligible population has used the project at least once (5% of total population)
- One-sixth of the eligible population uses the project during any one month (3% of total population)

Seventy-two percent of all registered persons are over 65 years of age; the remaining 28% are handicapped, or under 65. One-fourth of the elderly registered report that they are handicapped. Table M-2 compares registered and non-

registered eligible persons from surveys concerning socio-economic and demographic characteristics. The registered group has a greater fraction of females, has significantly fewer transportation alternatives and significantly less household income than those persons who have not registered. Only one-quarter of those registered have independent mobility as drivers compared to three-fifths of those not registered: one-half of those registered depend on others for rides as opposed to one-third of those not registered; and one-sixth of those registered report not driving and not receiving rides from others in contrast to only a few percent of those not registered. In addition, the low income status of those registered is very apparent. Almost twice as many registered persons (73%) as non-registered persons (41%) live in households with less than $5,000 annual income.

TABLE M-2

SOCIO-ECONOMIC CHARACTERISTICS OF ELIGIBLE POPULATION
(DANVILLE, ILLINOIS)

	Registered	Non-Registered	All Eligible
(sample n) =	(2352)	(213)	--
	(%)	(%)	(%)
A. Age & Handicap			
65 & Over, Handicapped	19	NA	NA
65 & Over, Non-Handicapped	63		
Under 65, Handicapped	18		
	100		
B. Sex			
Male	29	40	36
Female	71	60	64
	100	100	100
C. Alternative Transportation Available			
Not Driver/Receives No Rides	16	3	7
Not Driver/Receives Rides	59	36	44
Driver/Auto Avail/Rides	25	61	49
	100	100	100
D. Difficulty Using Taxis			
Cannot/Great Difficulty	1	4	3
Some Difficulty	5	9	8
No Difficulty	94	87	89
	100	100	100
E. Difficulty Using Buses			
Cannot Use	7	10	9
Great Difficulty	5	4	4
Some Difficulty	12	10	11
No Difficulty	76	76	76
	100	100	100

TABLE M-2 (continued)

F. Annual Household Income

Under \$5,000	73	41	52
\$5,000 - \$10,000	24	42	36
Over \$10,000	3	17	12
	100	100	100

G. Employment Status

Unemployed-Looking for Work	1	1	1
Working Full Time	1	5	4
Working Part Time	6	9	8
Keeping House/Retired/Other	92	85	87
	100	100	100

Individual project use on the part of those signed up has been moderate. Looking at the approximately 1,250 persons who use it during any one month, the median project use is 4 one-way trips per month and the mean use is 6 one-way trips per month. These figures are much lower if one considers all persons who have used the project at least once or all registered persons. This level of use is far below what the monthly limit would allow which, on the average, would be 15 one-way trips per person per month.

Total demand for project fare trips is depicted in Figure M-3 for each month of the project. At present, it is not certain whether demand is stabilizing or still growing as the seasonally adjusted curve indicates. The seasonal adjustment factor used is one derived from total taxi volumes (for all riders) in Danville in previous years. This adjustment factor may or may not accurately represent target group seasonal patterns.

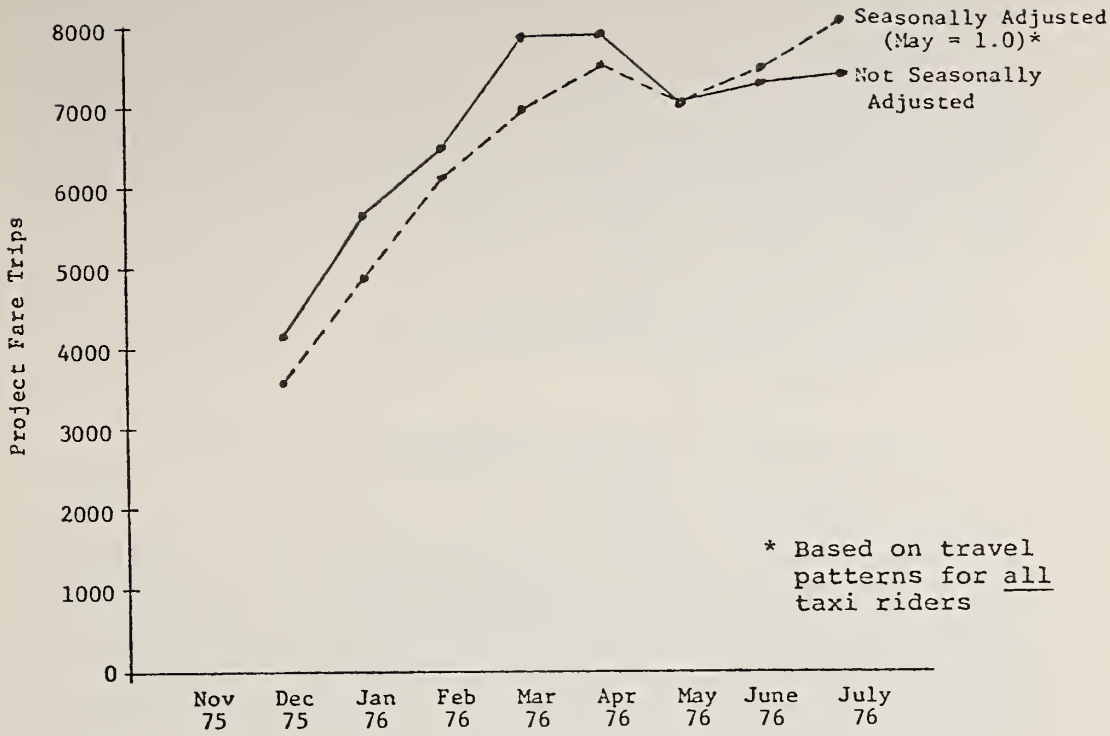


FIGURE M-3. RTR PROJECT RIDERSHIP TRENDS
(DANVILLE, ILLINOIS)

The volume of person trips is approximately the same as for fare trips - with a factor of only 1.05 RTR passengers per project fare trip. Total passengers (including non-RTR riders) per project fare trip is 1.2 (during the 7 a.m. to 7 p.m. period). This is the same as for non-project fare trips. Shared riding for 30% of all fare trips further increases the average passenger load per vehicle trip. Taxi vehicle productivity (for project as well as non-project trips) is 3.9 fare trips per driver hour. Thus, approximately 4.5 passengers are carried per driver hour on a 24-hour basis.

Trip lengths have been averaging 2.5 miles. The average in-vehicle travel time has been 8.5 minutes. Wait times have been about 4 minutes.

The average total taxi fare per RTR passenger trip (one-way) is $1.33; the RTR user share is $.35 per passenger trip; subsidy cost is $.98 per passenger trip. Tipping adds another $.05 cost per trip for the users. These are very low cost figures in comparison to publicly operated door-to-door demand actuated service. Factors contributing to this high productivity per subsidy dollar are:

- Low labor costs
- Efficient dispatching system
- Shared riding
- Use of standard five-passenger vehicles
- Low overhead costs

Drivers are paid a flat commission of 40% on all fares plus tips. There is a minimum guarantee of $1.90 per hour in the case of the largest cab company. The average commission per driver, during the project, has been $2.27 per hour. Tipping adds another $.20 per hour. With addition of some wage costs due to the minimum guarantee, the total payments to drivers averages approximately $2.50 per hour.

Both of the large cab companies, in direct competition with each other during the year-and-a-half before the project began, were losing money. Thus, fares were not covering costs at that time. With the RTR project ridership beginning December 1975, both cab companies experienced immediate improvement in revenue cost ratios. The second largest cab company, however, was faced with certain bills (non-project related) that it could not afford on a short-term basis and, therefore, discontinued operations. The largest cab company subsequently absorbed 98% of all taxi volume and is presently making a profit.

Subsidized project trips as a fraction of total volume has steadily increased and presently is 28%. Total taxi volumes during the first five months of the project increased significantly over demand levels of the previous year (see Figure M-4). However, eight months into the project, total taxi volumes are much closer to the previous year's levels. The decrease back to the previous year's

levels cannot be explained by any comparable decrease in project trips. However, it is possible that the drop in level of service following the discontinuation of service by the number two cab company (end of April 1976) has caused a decrease in demand in both project and non-project taxi trips. Thus, at present, it is hypothesized that the project has increased taxi volumes by approximately 15-20%, while the exogenous change in level of service has caused an equal decrease. Results from two on-board surveys indicate that project ridership, by increasing demand on the part of elderly and handicapped persons, has not adversely affected cab company operations. While target and non-target group demand characteristics are different (i.e., target group persons take less time to get on the cab, take shorter trips, and take longer to unload), calculations indicate that target group rides pay for themselves as well as do non-target group rides.

Those who have signed up for the program report a high degree of satisfaction with the project--only two percent rate it as "fair" or "poor;" 57% rated the project as "excellent" and 41% rated it as "good." Over 58% reported no problems with signing up for the project, use of the I.D. card, signing the charge slips, or cost of project trips. Four percent reported problems with the monthly limit; 7% reported problems with driver courtesy and 14% reported problems with the promptness of taxi service. With regard to the latter, however, those who used taxi service before the project began were asked to rate the present taxi service in comparison to before. While 7% rated it as "worse," 55% rated it as the "same" and 40% rated it as "better."

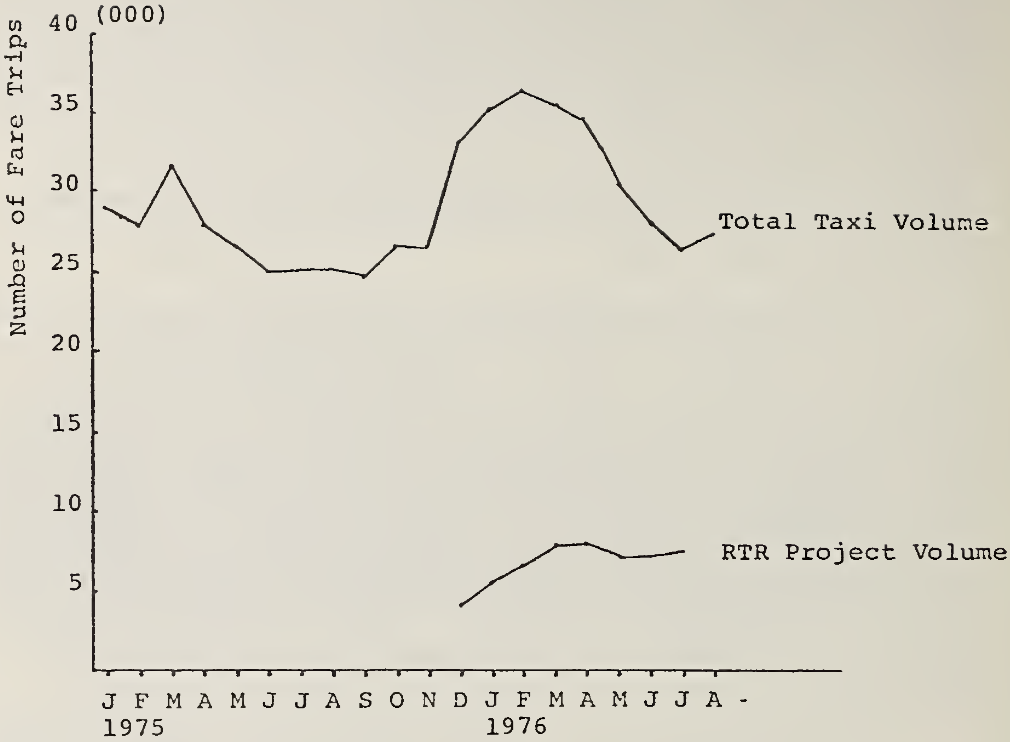


FIGURE M-4

FIGURE M-4. TOTAL TAXI VOLUME & RTR PROJECT VOLUME
(DANVILLE, ILLINOIS)

In the same survey, users were asked if the project had affected them in any of the following ways:

	Yes	No
• Take more trips now?	41%	59%
• Less dependent on others for a ride?	58%	42%
• Drive less often now?	7%	93%
• Able to take more trips during a particular part of the day?		70%
Morning	13%	
Afternoon	14%	
Night	3%	
• Able to take trips which couldn't take before?	43%	57%

Those who reported being able to take new trips with the help of the project reported frequency of purposes for the new trips in the following order:

• Shopping	38%	• Church	5%
• Visit	18%	• Social Activities	5%
• Medical	11%	• Emergencies	4%
• Personal Business	8%	• Other	11%

Those who have registered but not used the project (20% of those registered) report primarily that they have an I.D. card in case they need to use it; some 3% of those signed up, however, report that they would have physical difficulty using a taxi.

Persons who have not registered report the following primary reasons for not doing so.

• Don't need to, have alternative transportation	68%
• Didn't know about eligibility	9%
• Intend to - just haven't gotten around to it	3%
• Don't need to, don't travel much	3%
• Can't use taxis for physical reasons	3%
• Not interested in subsidized program	3%
• Other reasons	11%
	100%

IMPLICATIONS

The Danville project, to date, has proven the viability of the user-side subsidy concept and the use of private taxi suppliers in providing increased and improved transit service to the handicapped and elderly. However, from a resource allocation standpoint, it is important to note that a majority of handicapped and elderly users of the project do not require door-to-door service for all trips.

A substantial proportion of all eligible persons (one-third) have registered for the project. Project use, on an individual basis, has been moderate. Users report a high degree of satisfaction with the project and cite tangible results for themselves.

Subsidy costs per passenger trip are low in comparison to publicly operated door-to-door demand actuated systems, and both cab company operators and drivers are benefiting from the increased business. Wage costs based on commissions (% of fare) and efficient operations are reasons for the high productivity in terms of subsidy spent.

A change in level of taxi service provided, due to one cab company going out of business, may have depressed project as well as non-project demand. However, seasonal adjustment factors suggest that project demand may still be increasing.

APPENDIX N

SYRACUSE CALL-A-BUS DEMONSTRATION PROJECT

OVERVIEW

The Syracuse Call-A-Bus demonstration was established to provide transportation services for elderly (55 and over) and disabled persons who found it difficult or impossible to use regular public transportation services. Door-to-door service for individual users was provided within Onondaga County, and buses could be used by organized groups for transportation purposes. Call-A-Bus (CAB) drivers were specially trained for working with the elderly and handicapped.

The Call-A-Bus demonstration also included the coordination of the efforts of various organizations in providing transportation services to the elderly and handicapped. The primary mechanism for accomplishing this task was the Call-A-Bus Project Advisory Committee, the policy-making body for the demonstration consisting of representatives from eighteen organizations. These organizations included nine private social service agencies, four government social service agencies, and a senior citizens' center, as well as the Central New York Regional Transit Authority (CNYRTA), the New York State Department of Transportation (NY-DOT), the Central New York Regional Planning Board, and the Syracuse University Gerontology Center. Through the group trip option, numerous other organizations were formally involved with Call-A-bus.

Funding for the project was derived from the following sources:

<u>Operations</u>	
UMTA (Grant NY-06-0041)	$333,000
State of New York	125,000
CNYRTA	42,000
Total	$500,000

Bus Purchases

UMTA (Grant NY-03-0055)	$132,843
CNYRTA	66,422
Total	$199,265

In addition, $11,170 in fiscal year 1975 and $10,000 in fiscal year 1976 was received from the Metropolitan Commission on Aging. This money came from Federal funds allocated through Title III of the Older Americans Act of 1965.

The Call-A-Bus demonstration began on October 1, 1973, and was concluded on October 31, 1975, after 25 months. It was conducted by CNY Centro, the operating subsidiary of CNYRTA. Since the demonstration's conclusion, CNY Centro has continued to operate Call-A-Bus, with only small service cutbacks.

OBJECTIVES AND EVALUATION ISSUES

The demonstration's objective of improving transit service for the transit-dependent makes it comparable to SMD projects, thus it is useful to study the results of the Call-A-Bus program along with SMD demonstrations that address the needs of the transit-dependent.

Other local objectives included the determination of the latent transportation demand of the elderly and handicapped, the acquisition of experience in operating such a system, and the coordination with other organizations in providing transportation services for the transit-dependent. The latter objective involved a strong cooperative effort with local social service agencies, health facilities, and senior citizen groups.

Key Issues to be Examined

The key issue associated with the Syracuse CAB demonstration is whether a specialized public transportation system for the elderly and handicapped can improve the mobility of these groups and therefore enhance the quality of their lives. Thus, determining the levels and characteristics of the latent demand manifested by Call-A-Bus is a prime concern of the demonstration. In addition,

the demonstration provided the setting in which the nature of the specialized transportation needs of the elderly and handicapped could be investigated. Finally, the Call-A-Bus demonstration provided an example in which an established public transportation authority supplied the special transit service; the effectiveness of this arrangement was also a concern.

The costs of Call-A-Bus operations naturally constrain the effort to maximize the mobility of the elderly and handicapped. The Call-A-Bus demonstration permitted the investigation of this tradeoff of cost and service in one type of system for the elderly and handicapped.

PROJECT DESCRIPTION

Site Characteristics

The CAB demonstration was confined to Onondaga County (see Figure N-1), a 794-square mile County in upstate New York with a population of 472,835 in 1970, of which 17.9 percent were over 55 years of age. Forty-two percent live in the City of Syracuse, located in the center of the County. Approximately 80% of the County's population resides in the Syracuse urbanized area, although the urbanized area occupies only 12% of the County's land area. Thus, most of Onondaga County consists of rural land. CAB provided service to all of Onondaga County, but most service and demand was concentrated in the City of Syracuse.

CNY Centro, which operates CAB, is the primary provider of public transportation service in Onondaga County and operates 46 regular routes. Three smaller suburban carriers provide additional service to suburban locations, carrying about 5% of the County's transit ridership. The basic fare on CNY Centro routes is $.35; the elderly and handicapped may ride during the offpeak for $.15. Based upon a 1971 survey, approximately 15% of the regular route bus riders are aged 65 or older.

The following table displays some of the more relevant 1970 demographic characteristics of Syracuse and Onondaga County (including Syracuse):

ONONDAGA COUNTY

FIGURE N-1. ONONDAGA COUNTY, NEW YORK

	Syracuse	Onondaga County
Population	197,297	472,835
Population density (per square mile)	7,647	596
Median family income (1969)	$9,246	$10,830
Percent of workers using public transit	15.2%	8.4%
Percent of population age 55 and over	23.0%	17.9%
Percent of population age 65 and over	12.9%	9.3%
Percent of persons 65 and over below low income level	21.6%	20.1%

Services and Innovations

Two basic services were provided under the CAB demonstration: regular CAB service and group trips.

Regular Call-A-Bus Service. Regular CAB service was a many-to-many, demand-responsive service for the elderly and handicapped, in which users requested service two or more days in advance. This advance calling was required in order to meet the demand more efficiently and provide reliable service. The extremely large service area made short-notice demand service difficult to handle efficiently.

Door-to-door service was initially provided to all elderly and handicapped persons between any two points within Onondaga County between 6:00 a.m. and midnight on weekdays, 10:00 a.m. and 6:00 p.m. on Saturdays, and 8:00 a.m. and 4:00 p.m. on Sundays. The minimum age of elderly passengers was set at 55, but this has not been strictly enforced. The fare was $.25. On November 12, 1973, just over one month after service initiation, the basic fare for trips within Syracuse and nearby suburbs was raised to $.50, and fares for trips to or from the more remote areas of Onondaga County were set as high as $1.00.

In December 1974, based on a demand study completed the previous spring, seven-day-per-week service was restricted to a 35-square mile area which included Syracuse and nearby

suburbs. The remainder of the County was divided into five sectors, and each sector was served on a different weekday. Weekday service after 10:00 p.m. was also eliminated at about the same time. Four buses were generally used to provide weekday service; one bus was used on Saturday, and two buses on Sunday. Occasionally, if demand warranted, an additional bus was placed in service.

To obtain regular service, it was recommended that a person call the dispatcher's office at least two days in advance with his request. (High demand sometimes caused users to request service as far as seven days in advance to assure a reservation.) The dispatcher then schedules the vehicle routes on the day before the trip and the customer's trip is confirmed by telephone between 3:00 p.m. and 5:00 p.m. that day. On occasion, the dispatcher will schedule a late request if there is room on a driver's schedule. There are also about forty "regular requests" in which a passenger travels to the same place on a regular basis (daily, once per week, etc.). These requests need not be phoned in each time.

A loose priority system is followed when demand exceeds the system capacity. Medical trips are given highest priority, followed by work and educational training trips.

Transportation of persons confined to wheelchairs has also been provided by the regular CAB service. Since April 1975, wheelchair lifts on all four regular CAB vehicles allow the handicapped to be transported along with other passengers without special scheduling. Thus, CAB provides a regular means of transportation for a population that has previously been totally dependent upon private means of transportation.

Group Trips. Group trips, which began at the demonstration's start in October 1973, are special bus trips carrying groups of 15 or more elderly and/or handicapped persons from one or a few origins to a common destination. The costs of a group trip are shared equally between CNY Centro and the sponsoring organization. Large fifty-passenger buses are usually used to provide this service.

The group trip service has enabled numerous groups--including informal senior citizens' clubs and church-related organizations as well as formal social service agencies--to sponsor trips for its members at a reduced cost.

HISTORY AND STATUS

A chronological listing of the principal events in the Syracuse CAB demonstration is as follows:

September 20, 1972	"Dial-A-Bus" service for the elderly and handicapped begins. Two-day advance calling is required for door-to-door service anywhere within Onondaga County. CNY Centro operates the system using one regular-sized bus. Funding comes mainly from the Office on the Aging, U.S. Department of Health, Education, and Welfare.
October 1, 1973	Call-A-Bus service begins, replacing the "Dial-A-Bus" system. Four regular-sized buses equipped with "kneelers" are used; additional buses are called when needed.
November 12, 1973	Base fare increased from $.25 to $.50; longer trips cost up to $1.00.
September 1, 1974	Call-A-Bus service eliminated between 10:00 p.m. and midnight.
December 1, 1974	Seven-day-per-week service restricted to Syracuse and three adjacent suburbs; remainder of County divided into five sectors and served one day per week.
March, 1975	Four small Mercedes-Benz buses with wheelchair lifts are phased into operation.
March 3, 1975	Transportation of underprivileged children to West Genessee Day Care Center begins.
April 7, 1975	Wheelchair transportation begins.
October 31, 1975	Demonstration concluded; CAB program continues under local funding.

Demonstration Phasing and Modifications

The basic CAB services, including regular CAB service and group trips, were fully implemented at the start of the

demonstration in October 1973. Demand for the services steadily grew over the demonstration period, causing the major service area alteration previously described to be made on December 1, 1974.

The other major change occurred on April 7, 1975, when transportation of persons confined to wheelchairs began. In addition to these major changes, several smaller programs were implemented during the course of the demonstration. For instance, beginning on July 12, 1974, service for the elderly was provided each Friday to the Jordan Nutrition Program, a hot-meal service for the elderly provided by a local community action agency. This service continued for over a year. In addition, daily transportation of underprivileged children to a day care center began on March 3, 1975. These and other such services did not alter the basic structure of the CAB program, but represented special services provided within it.

The only important delay in the project was in the securing of the small buses equipped with wheelchair lifts. This allowed only seven months for the operation of wheelchair transportation during the demonstration period. However, since CAB service has continued after the demonstration's conclusion in a basically unchanged form, a longer time period exists in which to evaluate the impact of this innovation.

The demonstration ended on October 31, 1975, but CAB operations have continued. The only major change that has occurred is that extra buses are not brought into regular CAB service even when warranted by demand. This has resulted in many passengers being denied service because of capacity limitations.

FINDINGS

Demand. During the two years of the demonstration, ridership on the regular CAB service steadily increased. During the initial four months of the demonstration, monthly ridership rose rapidly to around 3,000 passengers (140 per weekday). It then rose more slowly over the next 21 months due to the system capacity restriction. The highest level was reached during the demonstration's final month, when 5,205 passengers were carried (250 per weekday). Ridership tended to decrease slightly during the winter and summer, and was slightly higher during the spring and fall. This resulted from the relatively severe climatic conditions

experienced during the winter, and the suspension of many social service programs during the summer months.

Weekend ridership is considerably lower than weekday ridership. Saturday and Sunday ridership together make up only about 8% to 10% of weekly demand. Sunday ridership is much greater than Saturday ridership because many passengers use CAB to attend church services. Two weekday peaking patterns may also be discerned: The most severe peak occurs between 3:00 p.m. and 4:00 p.m. because of the transport of passengers from the Association for Retarded Children (ARC) and West Genessee Day Care Center. A secondary peak occurs between 8:00 a.m. and 9:00 a.m.

In addition to the regular CAB service, as many as 3,900 monthly passengers have been transported on group trips. There is a very distinct seasonal variation in group trip ridership. During the summer months, there are typically over 40 group excursions per month carrying over 3,000 passengers. During the winter, however, the number of monthly group excursions drops to ten or fifteen, and the number of passengers likewise declines. Between 40% and 45% of the annual group excursion activity occurs during the months of June, July, and August.

Two comprehensive origin-destination studies of regular CAB service indicated that most CAB users are Syracuse residents. In the March 1974 study, 59% of the trips began and ended within Syracuse, 33% had one trip end in Syracuse, and only 8% were entirely outside of that city. As a result of the December 1974 service area change which limited seven-day-per week service to the Syracuse area, the proportion of trips totally within Syracuse increased to 72%.

Information on the users of CAB comes from two on-board surveys conducted in March-April 1974 and in January 1976, and a mail survey of users completed in February-March 1976. In addition, certain user characteristics are recorded by the CAB telephone operators when passengers request service. These surveys have indicated that CAB riders are predominantly female (85%-90%) and that market penetration is greatest in the oldest age groups. Relatively few persons between the ages of 55 and 65 use CAB, although age 55 has been defined as the eligibility point for elderly users. Approximately 3% of the ridership is confined to wheelchairs. Including blind and infirm passengers, it has been estimated that between 10% and 15% of CAB passengers need some type of assistance in boarding. Approximately 20% to 25% of passengers are disabled in some manner. CAB users

also tend to have very limited incomes and are highly dependent upon transit. The general mail survey of users disclosed that over half had monthly incomes under $250 and about 2/3 lived in autoless households.

A six-month sample of CAB trip purposes showed that nearly one-third of all trips were for medical purposes; this constituted the single largest trip purpose category. Other important reasons for using CAB were personal business, recreation, personal visits, employment, and travel to a social service agency. CAB is very rarely used for shopping purposes. Most passengers (85%) made a round-trip on CAB. Based on the most recent on-board survey, it is estimated that 45% of CAB trips would not have been made if CAB were not available. CAB users were more likely to find an alternative for making the more essential medical and work trips, however. This suggests that CAB facilitates these trips and, in addition, provides a means of making other trips that are more likely to be sacrificed without it.

At the end of 1975, approximately 2,100 living users of CAB had been identified; this population was sampled in a mail survey. The majority of these persons (58%) used CAB infrequently, only once a month or less. Only about 6%, or 125 persons, use CAB more than once per week.

<u>User Attitudes Toward Call-A-Bus</u>. The most recent CAB on-board survey and the general users' mail survey contained an identical set of attitudinal questions in which respondents were asked to rate 13 attributes of CAB use. Overall, CAB users reacted very favorably, tending to indicate "excellent" in most cases. Generally, the less frequent users sampled through the mail survey responded similarly to those surveyed on-board. Three attributes, however, received significantly less favorable responses and may suggest why some persons use the service less frequently. These attributes included "Call-A-Bus availability when needed," "convenience for scheduling return trips," and "courtesy and helpfulness of the telephone staff." The less favorable response to the first two attributes might have been caused by the long advance request time often required and the restriction of service on outlying rural areas to one day per week. Attributes such as reliability, fares, travel time, ride comfort, the method of requesting service, and information availability were not generally perceived to be problems.

<u>Productivity and Economics</u>. For the regular CAB service, the number of passengers per vehicle-hour steadily

increased over the course of the demonstration, and reached 3.4 during the last month. Passengers per vehicle-mile also increased accordingly. These increases were achieved mainly by more efficient dispatching as more passengers were assigned to each vehicle tour. Trip lengths on CAB are relatively long due to the large service area and the average trip length has been estimated at over four miles.

The regular CAB operating cost per vehicle-hour averaged around $12.85 until February 1975, when an increase in drivers' wages increased this figure to $15.32 (capital depreciation costs of about $1.10 per vehicle-hour are excluded from these calculations). Approximately 42% of operating costs was for drivers' wages and benefits and 16% was for dispatching and scheduling. Altogether, direct wages including those for management and maintenance personnel accounted for about 80% of operating costs.

The cost per regular passenger declined over the demonstration from over $6.00 per passenger during the demonstration's first four months to under $4.50 during the final two months. With revenue per passenger at around $.48, revenues amounted to only 8.5% of operating costs during the demonstration period.

The cost per group passenger was generally under $1.00, and tended to decrease the overall system cost per passenger. During the summer months, when there was significant group ridership, the systemwide operating cost per passenger was usually about $3.00. Furthermore, the policy requiring group trip sponsors to pay for half of the excursion costs raised overall revenues up to 11.7% of system operating costs.

Coordination of Transportation Services. The prime mechanism for coordinating the supply of transportation services for the elderly and handicapped in Syracuse was the CAB Project Advisory Committee. This policy-making body met monthly during the demonstration, and assured that diverse interests were represented when policy decisions were made.

The group trip service was the second means of coordinating transportation services. During the demonstration, 73 organizations sponsored group excursions, including nursing homes and hospitals, religious-affiliated groups, government agencies, senior citizen centers and clubs, public and private housing developments, and private social service agencies, suggesting the wide impact of this service.

Assessment of Impacts and Problems Encountered. The CAB system was a limited-scale operation, and capacity on the regular service was approached a few months after the system was initiated. With a basic fleet of only four buses, service was provided throughout an 794 square mile County with an elderly population of nearly 85,000. This resulted in a demand that exceeded the system's capacity, and a trip priority scheme had to be adopted. During the demonstration, an additional bus was also occasionally employed to handle the excess demand.

The cost of regular CAB service on a per-passenger basis has tended to be high, and was $5.00 or more for much of the demonstration. The per passenger trip cost is slightly higher than for a comparable trip by taxi. The cost to the CAB user, however, is only 25 percent or less of the taxi fare. For those riders confined to wheelchairs (about 3 percent), other special transportation services, such as wheelchair taxis, cost at least $9.00 per trip in Syracuse. However, these special services will often assist the passenger between his origin or destination and the vehicle. CAB drivers are only allowed to assist passengers boarding or disembarking the bus at the curb. They are not allowed to take the passenger to or from the door of their trip origin or destination. This arrangement was worked out with representatives of private wheelchair cab companies which had expressed concern that the subsidized CAB program could put them out of business.

The level of ridership indicates that CAB has been relatively successful in extending transit coverage to the elderly and handicapped populations of Onondaga County but the system capacity limitation restricted the amount of demand that could be accommodated. Market penetration was greatest among the oldest age groups and the disabled, those groups with the greatest need for transportation services. Surveys revealed that nearly half of CAB passengers would not have made the trip if CAB was not available. These surveys also indicate that CAB is serving a relatively large population of occasional users rather than a small group of everyday users.

The most significant problem encountered has been that of satisfying all of the demand placed on the system. In December 1974, service to areas outside of Syracuse and certain adjacent suburbs had to be limited to one day per week. This, along with the long advance calling that has often been required in order to be assured of service, has lowered the perceived convenience of CAB to many users. The system capacity limitation also prohibited the determination

of the true latent demand for CAB which was stated as one of the key issues to be examined in the demonstration.

CAB, nevertheless, appears to have made a positive impact on the mobility and lives of its users. The group trip service, which has also been widely used by a diversity of organizations, has benefited these organizations and the people they serve. In recognition of these benefits, CNYRTA has continued to provide CAB service since demonstration funding expired in October 1975, despite unit costs exceeding those of other local transit services.

IMPLICATIONS

Implementation and management of the CAB demonstration proceeded smoothly and there were no significant exogenous factors which greatly influenced the outcome. Although the demonstration included the period in which there was a widely perceived gasoline shortage (1973-74 winter), the impact on CAB operations was not great due to the size and nature of the service. A significant feature of the CAB system was the large service area which was covered with only four vehicles. As already discussed, this had to be modified midway through the demonstration, but many of the results reported--especially vehicle productivity and cost per passenger--were greatly influenced by the extraordinarily large service area.

An important factor in CAB operations was that the program was developed and operated by a transit organization with considerable experience in providing transit services. Well-staffed maintenance and storage facilities already existed and were utilized by CAB. The CNYRTA had also gained special operating experience during the HEW-funded dial-a-bus program which existed prior to CAB. These circumstances all facilitated the implementation of CAB service.

The CAB demonstration is an example of the provision of door-to-door transit service for the elderly and handicapped in a medium-sized metropolitan area. It has demonstrated one approach to providing such service, and the results indicate what may be encountered in other areas contemplating similar services.

REFERENCES

1. SYSTAN, Inc., Evaluation Plan for the Syracuse Call-A-Bus Demonstration, December 1975.

2. Central New York Regional Transportation Authority and SYSTAN, Inc., Call-A-Bus: Specialized Transportation for the Elderly and Disabled: City of Syracuse, Onondaga County, New York (Draft Final Report, July 1976).

APPENDIX O

BATON ROUGE SPECIAL TRANSPORTATION SERVICES FOR THE ELDERLY AND HANDICAPPED DEMONSTRATION PROJECT

OVERVIEW

The Baton Rouge, Louisiana, Special Transportation Services (STS) for the Elderly and Handicapped (E/H) Demonstration Project was funded under an UMTA Service Development Grant designed to assess the performance of a specialized, experimental service which offered free, prescheduled, door-to-door transportation, specifically to meet medically related demands of the E/H. The demonstration service commenced in September of 1974 and concluded in December of 1975. Service was renewed in January 1976 under an HEW Title XX grant.

The 18-month UMTA grant was awarded to the Capitol Transportation Corporation (CTC) in March of 1974 as the system operator and administrator. Project funding information is indicated below:

UMTA Project Number	LA-06-0001
Grant Recipient	Capitol Transportation Corp.
Federal Share	$171,050
Matching Funds	$ 85,525

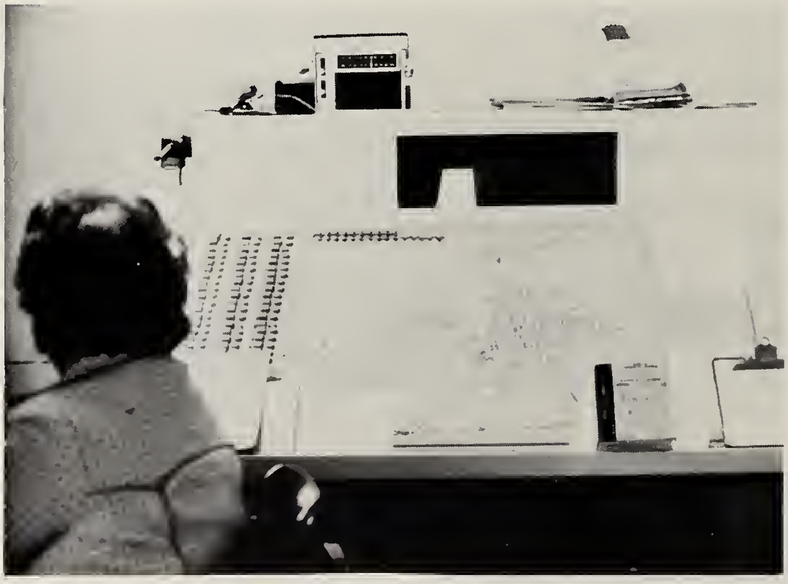
Although the project was to have ended formally in August of 1975, the availability of remaining funds permitted the demonstration to continue until December of 1975 when all public transportation ceased due to a strike of the CTC drivers.

OBJECTIVES AND EVALUATION ISSUES

According to the grant application (Reference 2), the STS project was intended:

> to demonstrate a modern, cost-effective method of transporting the aged and disabled by means of a specially designed system, separate from

Wheelchair-Equipped Van for Handicapped Persons,
Baton Rouge, Louisiana



Special Transportation Services (STS) Control
Center, Baton Rouge, Louisiana

conventional public transit, but coordinated with the community's existing public transportation resources.

This demonstration project, although not initially falling within the SMD Program, did address the major SMD objective to improve the mobility of transit dependent and was intended to test the feasibility of planning and implementing a specialized transportation service to provide access for the elderly and handicapped to medical services.

PROJECT DESCRIPTION

The special service offered by this system consisted of demand, pre-scheduled pick-up and delivery functions, dispatched through a central control facility. The STS was managed as a division of the Capitol Transportation Corporation (CTC), the local public transportation firm, but was not coordinated with existing public transit routes.

At the time the demonstration reached its full operational complement of vehicles, five Chevrolet Sports Vans were in operation. A sixth van was held in reserve to substitute when another van was in maintenance or repair. Each van was significantly modified during the course of the demonstration to meet varying needs of the elderly and handicapped clients, with two vans being fitted to handle wheelchair clients.

The concept being demonstrated called for pre-screened and eligible elderly and handicapped to call in to a central location with their trip requirements, at least one day in advance. Eligibility was clearly set forth during the planning stages of the project, but with some flexibility to modify as conditions changed. The STS central coordinator/dispatcher would confirm eligibility and would then schedule the client, taking into consideration other demands on the system for that time period. Where conflicts arose, every effort was made by STS personnel to make appropriate modifications (e.g., check with a doctor's office to see whether an appointment could be moved without too great a hardship).

The demonstration project was located in and around the capitol city of Baton Rouge, Louisiana, and encompassed approximately 88 square miles containing 248,000 people. In an effort to equalize the potential client distribution, and because only five vans would be available for operation, the service area was divided into five sectors (see Figure O-1).

STS Van, Baton Rouge, Louisiana

A - Baton Rouge General Hospital
B - Baton Rouge Mental Health Center
C - Baton Rouge Physycal Therapy & Rehabilitation Center
D - Doctor's Memorial Hospital
E - East Baton Rouge Parish Health Unit
F - Earl K. Long Hospital
G - Margaret Dumas Mental Health Center
H - Medicenter of America
I - Our Lady of the Lake Hospital
J - Perkins Radiation Center
K - United Cerebral Palsy of Baton Rouge
L - Womans Hospital
M - Nutrition Center
N - Nutrition Center (Pres. Church)

FIGURE O-1. BATON ROUGE, LOUISIANA, ITS ENVIRONS AND THE STS SERVICE AREA SECTORS

Using 1970 Census data, an estimate of the target population was calculated to be 18,300 elderly and handicapped (7.5% of total population). Using the same 1970 Census data to compare with demographics for the United States as a whole, the Baton Rouge service area population was found to be proportionately younger, had proportionately fewer people falling into the 65 and above age category, and had a higher ratio of blacks to whites.

PROJECT HISTORY AND STATUS

In the Baton Rouge service area, transportation was theoretically available to meet the medically-related demand of the E/H. Primary sources for such service were:

1. The Capitol Transportation Corporation (CTC) - provided fixed route service at no cost to the E/H when the STS started, but increased the fare to $.15 late in 1975. No easy routing to destinations existed and both access and egress were particularly difficult.

2. Taxi services - were used infrequently due to high costs. Generally, companions were required due to driver reluctance to provide service because of potential liabilities.

3. Social service agencies - were infrequently available due to no pre-established schedule and high dependence on availability of vehicles.

4. Private auto - was employed, usually by relatives of the E/H, for approximately 50% of the STS users prior to initiation of the service.

As a consequence of a survey conducted by the Easter Seal Society in June of 1971, it was determined that the most important area of health care for the E/H involved transportation to and from medical facilities. As a consequence, the Society initiated a handicab (Reference 3) service (two stationwagons) in January of 1972. A monthly average of 550 passenger trips occurred during the three months of operation, with 73 different clients being served. The service ended on March 31, 1972, due to a lack of funds.

Due to the interest generated by this activity, the City of Baton Rouge applied for funding under an UMTA-sponsored demonstration project. In July of 1972 UMTA awarded an 18-month Service Development Grant.

Special Transportation Services for the Elderly and Handicapped, Baton Rouge, Louisiana

Of the 18-month time period, six months were to be devoted to planning and acquisition of necessary equipment and 12 months to the actual in-service operations. (Because of available funds, the 12-month service was extended to almost 15 months, when the CTC was shut down due to a drivers' strike.)

During the balance of calendar 1972, negotiations continued to establish an acceptable demonstration plan. Arrangements were finalized and the City of Baton Rouge signed an agreement in January of 1973 with the Easter Seal Society to operate the handicab program. During the next few months vehicle specifications were developed. The Louisiana Easter Seal Society collapsed financially in August 1973, and had to be taken over by the National Easter Seal Society. This collapse necessitated a change in the operator of the program. UMTA accepted the Capitol Transportation Corporation (CTC) as the system operator and administrator, and, in March of 1974, the CTC Board of Directors passed a resolution accepting the demonstration grant and authorizing initiation of efforts to complete planning and initial project implementation.

Upon acceptance of the UMTA grant, an STS Operations Plan was developed (Reference 4). Service with four vans commenced on September 9, 1974, and ceased in December of 1975 due to the CTC drivers' strike. The strike was settled and service renewed under an HEW Title XX grant in January 1976. Operationally, the current service is the same as that offered during the UMTA demonstration period. However, HEW eligibility requirements have restricted usage by some former riders.

FINDINGS

Summary operational data is given in Table O-1. Two points in time are most important in analyzing this data:

1. In late October and early November 1974, due to a significant underestimate in system usage for physician-related medical needs, the eligible medical destinations were increased by adding para-medical destinations in late October and therapeutic destinations in early November. These two modifications, coupled with an increased public information and education effort through the social service agencies and medical facilities, apparently resulted in the increasing

TABLE O-1. SUMMARY STATISTICAL TIME SERIES ON STS CLIENTS, TRIPS AND COSTS[1]

	Client Trips	# of Diff Clients Served Monthly	Avg # of Vehicle Miles Per Vehicle/Day	Costs Per			
				Vehicle Hour	Vehicle Mile	Client Trip	Day of Opr.
Sept 1974	239	79	33	$12.60	$3.84	$33.73	$504
Oct.[2]	855	199	75	9.44	1.26	10.16	378
Nov.[2]	1,899	279	101	10.32	1.02	4.35	413
Dec.	2,066	314	108	11.69	1.08	4.75	468
Jan 1975	2,739	372	123	10.85	.88	3.49	434
Feb.	2,738	422	133	11.44	.86	3.34	458
Mar.	2,984	436[3]	133	11.82	.87	3.17	473
Apr.	3,383	*	143	11.23	.79	2.92	449
May[4]	3,432	*	127	10.02	.79	3.21	501
June	3,277	*	132	10.25	.77	3.28	512
July	3,120	*	120	10.23	.85	3.61	511
Aug.	3,021	*	129	10.04	.78	3.49	502

[1]Source: STS operational records.

[2]More eligible destinations permitted in late October and again in early November.

[3]Of 1,237 registered at that time.

[4]A 5th operating vehicle added.

* Although this data was available in S.T.S. records, individual trip data was not processed for inclusion in the analyses in this report.

trend for ridership and number of different clients served monthly.

2. In May of 1975, a fifth operational van was introduced. Although data collected was not specifically oriented to determining why ridership declined from that point through the balance of the demonstration period, it appeared that the availability of family transportation increased during the summer months due to vacations and schools being closed.

The project objective, as set forth in the grant application, was subdivided into four major objectives for purposes of assessing the project. These objectives and the associated findings follow:

Objective 1: Meet the transportation needs of the elderly and handicapped.

Approximately 10% of the target population were certified to use the system as of August 31, 1975, and 2-3% of the eligibles were, in fact, using the STS. In general, the lower socio-economic sectors of the service area provided proportionately greater numbers of riders. Of the clients using the service, 13% required wheelchairs; and one-third of these required an additional companion. Very few new trips appear to have been generated by the service, primarily because most medical trips would have been made somehow, regardless of the difficulties involved in arranging travel. Data is not available to determine whether some prior trips are being made more frequently than before.

Objective 2: Operate a cost-effective method of transporting the aged and disabled.

STS service costs do not seem unreasonable when compared to taxi costs for comparable trips. For the final four months of the demonstration period, average operating costs per client trip were $3.40 and per vehicle hour were slightly over $10.00. If the STS did not exist and taxi operators were subsidized for STS-type trips, it would cost $3.00 for a 3-2/3 mile trip, the average STS user trip length. While the operating cost

of the fixed-route buses are considerably less, the evident disadvantages associated with access and egress problems, plus routing constraints, made the bus an unacceptable alternative.

Objective 3: Provide the transportation services for the elderly and handicapped by means of a specially designed system separate from public transit.

The STS service has expanded coverage for the target population by providing a door-to-door service for medical-related trips anywhere in the project service area. Since it is easier to use for the E/H, it has lessened client dependence and increased client mobility as well.

Objective 4: Coordinate the STS with the existing public transit system.

Although the CTC served as a shelter for STS operations, it was not essential to the successful operations of these services.

No efforts were made to coordinate the CTC schedules into STS pick-ups and deliveries; therefore, no further assessment can be made on this project objective.

Based upon a survey conducted by Southern University's Transportation Center, better than 90% of the STS users considered the service as good or excellent. Several instances were noted in which user rehabilitation was effected, a rehabilitation which might not have occurred without the STS. In addition, numerous medical facilities commented most favorably on the STS and its impact on the user group and the community. It was indicated that cancellations in at least one major clinic dropped between 60% and 70% within the first year of STS operations. Existence of the STS made it possible for individuals who could not obtain other modes of transportation with regularity to visit relatives at hospitals or clinics and specific destinations, such as nursing homes, more frequently and without burdening others.

IMPLICATIONS

The STS service has provided users with a greater sense of independence, an increased mobility, and an easier vehicle to use. These factors represent benefits to the community, especially in terms of the importance of the medical trips provided.

In assessing the approximately $3.40 operating cost per client trip, the following should be noted:

1) The rather large service area (88 square miles) and the resultant fairly long trip lengths (3.6 mile average) tended to lower productivities (3.0 pax/vehicle hour) and increase operating costs.

2) The large percentage of wheelchair clients (13%) compared with other similar services (typically 0-3%) tended to lower productivities and increase operating costs.

3) The relatively low drivers' compensation (salaries and fringe benefits) and maintenance costs compared with most other locales tended to lower operating costs.

While the STS system operations tended to move smoothly after the first few months of implementation, certain points should be noted when considering adopting a service such as this:

1. A preliminary systems analysis on total vehicle-related requirements and operating procedures is essential to avoid unnecessary and costly modifications in both hardware and operations.

2. More suitable vans than those utilized would have been preferred. Such vans should consider ease of entry and exit, seating arrangements, ramp and lift loading devices, wheelchair tie-down devices, engine configuration, and subsequent impact on maintenance time.

3. Client eligibility requirements must be carefully set forth prior to service initiation to permit adjustment for differences between actual and expected demand. There exists a need to allow a leverage for expansion of the system where expectation is not realized.

REFERENCES

1. McCall, C.H., Olson, M.I., and Reed, H., "The Special Transportation Services for the Elderly and Handicapped Demonstration Project in Baton Rouge, Lousiiana," Final Report, CACI, Inc. - Federal, Los Angeles, California, June 1976.

2. Parish of East Baton Rouge and City of Baton Rouge, "Application for Mass Transportation Demonstration Grant," Project Description, May 1972.

3. "HANDICABS -- A Concept. Easter Seal Society for Crippled Children and Adults of Louisiana, Inc.," March 17, 1972.

4. Capital Regional Planning Commission, "Program of Operations for Special Transportation Services. A Transportation Service for the Elderly and Handicapped," July 1974.

APPENDIX P

CLEVELAND NEIGHBORHOOD ELDERLY TRANSPORTATION DEMONSTRATION PROJECT

PROJECT OVERVIEW

In March 1975, the City of Cleveland inaugurated the Neighborhood Elderly Transportation (NET) Demonstration Project to coordinate transportation services to meet the mobility needs of the elderly (60 years of age and over) living within three inner-city demonstration neighborhoods. The NET system provides advanced reservation and demand-responsive service that is coordinated through the use of specially equipped small buses.

The twelve-month experimental demonstration began operation on March 16, 1975. It was funded jointly by UMTA and the HEW Social and Rehabilitation Service with local assistance from the City of Cleveland, Greater Cleveland Foundation, Greater Cleveland Regional Transit Authority (RTA),[1] and the Buckeye Development Corporation. Project funding was shared as follows:

UMTA (OH-06-0018)	$450,000
HEW (SRS)	250,000
City of Cleveland	230,000
Cleveland Foundation	50,000
Buckeye Development Corp.	6,000
RTA	18,675
TOTAL	$1,004,675

[1]The Cleveland Transit System (CTS), which provided public transit for the City of Cleveland, was absorbed by RTA shortly after RTA's creation in July 1975.

OBJECTIVES

The concepts established in this project relate directly to the fifth objective stated in the Service and Methods Demonstration Program; that of improving service for that portion of the transit-dependent population which is elderly and handicapped.

Additional project objectives, both local and national, are briefly outlined below. The NET Demonstration Program was designed to determine:[2]

- the extent to which a specially designed neighborhood transit system enables elderly and handicapped persons to maintain a state of independent living,
- the characteristics of both users and non-users,
- the feasibility of a public transportation system providing specialized services for the elderly and handicapped as part of its everyday operations,
- the extent to which basic transportation needs of the elderly can be satisfied within the neighborhoods in which they reside, through the use of a specially designed system,
- the level of increase or decrease of activity in social service and health organizations due to a neighborhood level of transit, and
- the necessity of serving all neighborhood residents, not just the elderly, to improve the economic feasibility.

The major issues that were to be examined in the evaluation were:

- Would the cost of this service, as provided by RTA and using organized labor wage rates, produce a system that would be too costly to continue <u>after</u> the grant was terminated?

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[2]Taken from "Proposal to Urban Mass Transportation Administration for Neighborhood Elderly Transportation Project," submitted by City of Cleveland, December 8, 1972.

- Will this form of service, with what is essentially a self-certification system, really reach the hardcore handicapped and transit-dependent?

- What, if any, compatibility or competition would there be with the existing transit system using the self-certification process?

- Can the existing system of job classification be modified and can drivers be retrained to carry out the new work requirements of a demand-responsive service?

PROJECT DESCRIPTION

Personalized door-to-door transportation was provided to elderly and disabled citizens on a demand-responsive or advanced reservation basis to and from desired destinations within each selected neighborhood. All persons over 60 years of age were eligible, and were required to show the driver either a medicare card or an NET Identification Card.

This service was provided with 12 Airstream "Argosy" buses and 2 Dodge "Maxivans" equipped with wheelchair lifts and tie-down devices. These vehicles operated on a non-fixed route concept, combining demand-responsive and advanced reservation service to both elderly and handicapped clients and their assistants for a fixed fare of 10 cents each. In addition to the door-to-door service, drivers were required to give personal attention and assistance to each passenger.

Service was offered from 7:00 a.m. to 7:00 p.m. five days a week and from 7:00 a.m. to 3:30 p.m. on weekends. Eligible patrons would telephone the dispatching center and give their trip information. Although prescheduling was encouraged, advance reservations were not required.

The City of Cleveland contracted to RTA for the operation of the system, including maintenance, fueling of vehicles, and the dispatching. Members of the Amalgamated Transit Union, indicating an interest in the project, were assigned to NET on a seniority basis. A two-week training session was held for all staff prior to the start of the service.

Bus Used in the Neighborhood Elderly
Transportation Project, Cleveland, Ohio

Site Characteristics

The service area consisted of three distinct low income neighborhoods: Buckeye, Model Cities, and Tremont (see Figure P-1). The relevant characteristics of each demonstration neighborhood were:

	Buckeye	Model Cities	Tremont
Area (sq. miles)	2.4	2.3	2.9
# of Residents 65+ Years of Age	4,302	3,911	3,534
# of 65+/sq. mile	1,790	1,700	1,220
% of Residents 65+	14%	10%	12%
Ethnic Origin(s)	Hungarian, Slovak, Black	Black	Polish, Greek, Slovak, Philippino

The three neighborhoods also contain sufficient activity centers and services to satisfy most of the basic daily needs of elderly residents. The neighborhoods are located within the service area of the new Areawide Model Project on Aging, which was established to improve the existing service delivery system in order to prevent life crises among older persons. Efforts have been made to establish lines of communication with elderly residents of each neighborhood.

Because the service was confined to certain areas of the city as opposed to being city-wide, advertising/ promotion efforts were generally confined to direct mailings (brochures, phone stickers, etc.) staggered throughout the demonstration period as well as efforts through the various service organizations for the elderly in each area. Some supportive city-wide coverage was provided by major newspapers and electronic media.

The demonstration was the coordinated effort of over 12 agencies and organizations including the Regional Transit Authority, the Mayor's Commission on Aging, Model Cities and the Areawide Model Project on Aging.

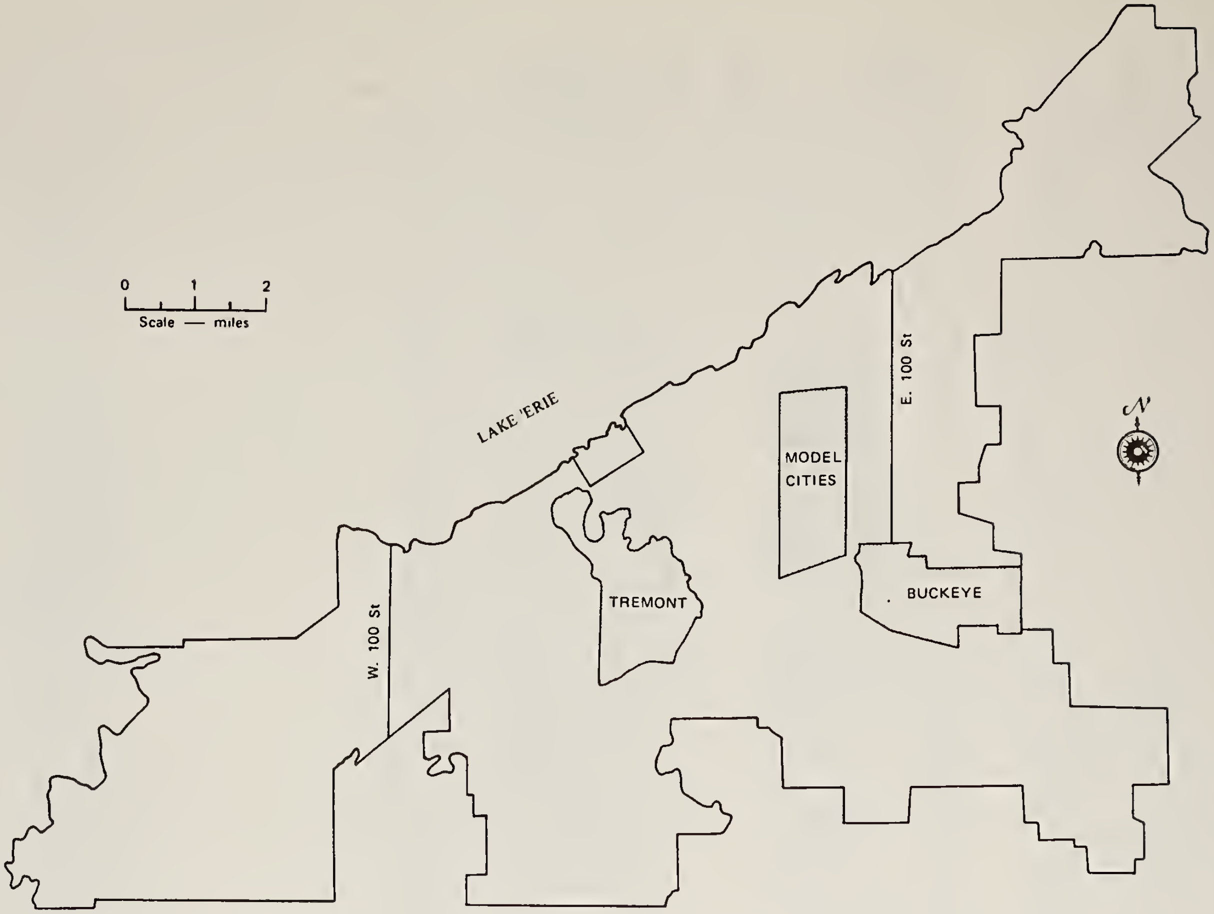

FIGURE P-1. CITY OF CLEVELAND, ELDERLY TRANSPORTATION DEMONSTRATION NEIGHBORHOODS

PROJECT STATUS AND HISTORY

Planning began for Cleveland's NET system in December 1972. The grant was awarded by UMTA and HEW on July 8, 1973. Further implementation planning, with the assistance of a transportation consulting firm experienced in NET-type operations, continued until the commencement of the demonstration period on March 16, 1975. The project was to have been completed by December 31, 1975, but since unspent project funds were available, the service was continued until March 31, 1976 to provide the City of Cleveland with additional time to plan a continuation of services. UMTA later provided funding to extend the project to July 1, 1976; however, this latest extension is not regarded as a part of the official demonstration period.

As was mentioned previously, efforts were made to ensure the continuation of transportation service within the target areas. The evaluation results contained in the final project report were used in deliberations to determine the ongoing policies. In January 1976, the RTA Policy Body adopted a set of recommendations on community-responsive transit (CRT).[3] This policy statement includes general recommendations for applying CRT to Cleveland and Cuyahoga County.

In March 1976, the NET operations were taken over by RTA. After examination of all available data, RTA decided to continue the CRT service to the same target areas used during the demonstration period. The RTA analysis included estimates of service levels required to reduce the cost per trip from that experienced by NET. The new service differs from the old in that the hours of service have been curtailed slightly, the age limit raised from 60 to 65, service changed to an advance reservation system, and the fare reduced to 10 cents during peak periods and free at other times (see Table P-1).

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[3]CRT is a term used in Cleveland meaning a transit service that operates within and is specifically tailored to a given community. It often is visualized as a demand-responsive service, but could have carefully designed fixed routes.

TABLE P-1

COMPARISONS OF NET AND CRT

	NET	CRT
Fare	10¢	Free-Non-peak hours 10¢-Peak hours
Area Served	Buckeye Model Cities Tremont	To be expanded throughout service area
Eligible Population	17,500	Approximately the same
Age	60+ & handicapped of all ages	65+ & handicapped of all ages
Number of Vehicles	14	33-53
Days, Hours of Operation	M-F 7am - 7pm SAT 7am - 7pm SUN 7am - 7pm	9am - 3pm none 8:30am - 1:30pm
Service	Dial-A-Bus (short notice)	Reserve-A-Ride (at least 24-hour notice)

The major change, however, aimed at significant cost reduction, came through labor negotiations that allowed a new driver classification at a reduced wage scale for this special service. The new wage rate is 31% below the regular scale. Also, based on the new labor agreement, a portion of the transportation service may be subcontracted to taxi companies who had proposed providing the demand-responsive service for about $10 per vehicle hour.

FINDINGS

System ridership and trends, travel time, and productivity are shown in Table P-2. The most substantive findings of this project related to certain issues concerning economic feasibility and user benefits. These results are:

1. The demand-responsive service, using specially equipped buses, was well liked by the seniors who used it. In a survey of 100 users conducted during the demonstration (as shown in Table P-3), respondents particularly identified the door-to-door service, the special assistance of drivers, the low fare, the ease of boarding and deboarding and the assurance of personal safety inherent in the service as the most desired features.

2. Although a rigorous benefit analysis was not conducted, surveys of users and non-users were conducted which suggested that the mobility of users was increased and that they were able to make more trips to more desirable destinations at less cost to them.

3. The cost of providing a reasonable level of "many-to-many"* demand-responsive bus service and the use of unionized RTA drivers, earning transit industry wages, was about $22 per vehicle hour. System productivity averaged 5.5 passenger trips per hour. The average cost per trip thus was $4.00, while an average trip length was about one and one-half miles.

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*Carrying all passengers from all origin points to all desired destination points within the prescribed areas.

TABLE P-2

RIDERSHIP DISTRIBUTION BY WEEKDAYS/WEEKENDS

Average Ridership by Day of the Week	% of Week's Total Ridership
Monday	15.5
Tuesday	15.9
Wednesday	16.8
Thursday	17.5
Friday	17.6
Saturday	8.2
Sunday	8.5

Distribution of Ridership by Time of Day[5]	% of Average Daily Ridership
Morning 7am - 10am	17.3
Midday 10am - 4pm	68.7
Afternoon 4pm - 7pm	14.0

AVERAGE TRAVEL TIME	10.6 minutes
AVERAGE WAIT TIME	24 minutes
AVERAGE PICK-UP TIME	2.3 minutes
VEHICLE PRODUCTIVITY	
Average Number of Passengers Per Vehicle-Hour	5.5
Total Vehicle Mileage	172,865
Total Passengers	100,397
Passengers/Mile	.58
Revenue Mileage[6]	141,749
Total Passengers/Revenue Mile	.70

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[5]Based on April through December 1975 period.
[6]Eighteen percent less than total vehicle mileage.

TABLE P-3

ADVANTAGES OF THE NET SYSTEM

Feature or Characteristic	% of Survey Respondents Citing the Feature
Door-to-door service	66
Assistance from drivers	48
Low fare	40
Low steps	34
Security	31
Reliability	21
Special design of bus	19
Wide doors	15
Special handles	12
Information received	11
Wheelchair lift	8

4. Some of these costs are inherent in the nature of the demonstration. For example, the NET operational areas and the available garaging for the NET vehicles were not in close proximity, causing considerable dead-head mileage. Thus, some minor cost reductions would be readily obtainable in developing a permanent operation.

5. It was concluded that more significant cost reductions would be possible if certain operational changes were made--limiting the hours of operation, requiring advance reservation of certain trips, and handling less important trips only if the system has the capacity to handle them. This would allow better "packaging" of trips, thus increasing productivity.

6. The demonstration service provided competition to the existing fixed-route service. Three-fourths of users reported that they were physically capable of using the existing service and the largest "before-to-after" mode shift was from the existing bus service to the demand-responsive demonstration service.

7. Based on the surveys conducted, users of the system, compared to a control group of non-users, were less handicapped, more capable of using the existing public transportation and had nearly as much automobile mobility (see Tables P-4 and P-5). The certification process was, in general, a self-certification process by those who could prove themselves to be over 60. There was not a continuing outreach program implemented to reach the severely handicapped or disabled elderly. More aggressive and able-bodied individuals seemingly utilized the service more often than those needing it more.

TABLE P-4

ABILITY TO PERFORM DAILY ACTIVITIES--USERS/NON-USERS

Activity		Unable To Do	Need Help	Can Do Without Assistance
Heavy Cleaning	Users	31	21	48
	Non-Users	27	38	35
Grocery Shopping	Users	30	26	44
	Non-Users	20	36	44
Using Stairs	Users	17	11	72
	Non-Users	18	31	51
Using Public Transportation	Users	15	9	76
	Non-Users	23	28	49
Laundry	Users	13	7	80
	Non-Users	11	36	53
Cooking	Users	9	6	85
	Non-Users	4	36	60
Bathing	Users	5	5	90
	Non-Users	3	31	66
Walking Around Home	Users	3	2	95
	Non-Users	4	29	67
Dressing	Users	2	1	97
	Non-Users	0	33	67

TABLE P-5

USE OF TRANSPORTATION MODES

Mode	Frequency	Users	Non-Users
Public Transportation	At least weekly	42	32
	Less than weekly	42	25
	Do not use	16	43
Personal Automobile	At least weekly	11	28
	Less than weekly	1	2
	Do not use	88	70
Relative's Automobile	At least weekly	22	22
	Less than weekly	29	34
	Do not use	49	44
Other's Automobile	At least weekly	23	13
	Less than weekly	28	20
	Do not use	49	67
Commercial Taxi	At least weekly	4	2
	Less than weekly	26	20
	Do not use	70	78

8. The training and use of RTA drivers as schedulers/dispatchers was generally successful, although considerable difficulty was encountered. Drivers were allowed to volunteer for this new project with selections of these volunteers based on seniority. This probably did not produce the best obtainable personnel, relative to efficiency and customer service, since driver attitudes and public relations skills are more pertinent prerequisites than seniority for the scheduling/dispatching work. Use of drivers as dispatchers also produced some conflicts of interest where the dispatcher had to oversee the performance of their fellow drivers and fellow union members.

IMPLICATIONS

There appear to be five aspects of the Cleveland NET experience which would be of interest to other cities and which relate to transferable findings. These are:

1. The post-demonstration re-design of the demand-responsive service to cut costs and improve productivity.
2. The laissez-faire or self-certification process that apparently did not lead to the most handicapped seniors being certified to use the service.
3. The problems encountered in using RTA drivers for the scheduling/dispatching function.
4. The post-demonstration development of the new labor classification and pay rate for drivers of the NET-type service.
5. The development of the capability to subcontract a portion of the NET-type service to taxi operators.

Some commentary on each of these aspects is given below:

Service Re-Design

The major lesson learned from the during and post-demonstration experience is that seniors find the door-to-door demand-actuated responsive service exceedingly attractive. At the same time, most are willing and able to modify their travel behavior to accommodate a more

Dispatcher Coordinating Demand-Responsive
and Advance Reservation Bus Service in Cleveland,
Ohio

restricted service level as evidenced by their continued usage of the post-demonstration service. Scheduling can be done on a 24-hour reservation process, the hours of service can be restricted, and people can shift their travel times or find other means of transportation.

When the NET hours of service were cut back in April 1976, there was an unexpected drop in ridership. As previously mentioned, surveys conducted during the demonstration period show that the majority of riders had the physical capability to use the fixed-route service and when the service cut-back was made, some apparently did so.

Laissez-Faire Certification

The offering of the NET service to all seniors, regardless of physical condition, may have been a rational and desirable policy. Although it allowed considerable diversion from the fixed route service, it did offer a higher level of service with considerably more personal security. This trade-off must be dealt with by any city or regional planning body in offering specialized services to the elderly. What is more important is that many of the more handicapped seniors apparently did not receive the service. This suggests that if the objective is to serve the extremely handicapped and shut-in person, some form of marketing program is needed to inform these people and help them to learn how to use the service they so badly need.

Drivers as Dispatchers

There did appear to be significant problems resulting from the use of senior RTA drivers as dispatchers. As one would expect, years of experience in bus driving or rapid transit operation is not related to such dispatching tasks as making transportation arrangements by phone, making quick re-routing and re-scheduling decisions, dealing with customer complaints, late arrivals, and so forth. These types of activities are the exact opposite of what most bus drivers are trained to do, which are to carry out tasks which are totally procedurized.

There were also very real conflict-of-interest problems. The nature of demand-responsive operations is such that a bus driver has considerable flexibility. He/she can take a work break any time the bus is without passengers and only the dispatcher can possibly know. The work rules of many transit properties forbid one member of the union

bargaining unit to report on the work performance of another member. As suggested by DAVE Systems, Inc., the system design consultant, it may be more appropriate that individuals from the transit property office staff, who are often in another bargaining unit, be trained for the dispatcher roles.

Contracts with Taxi Operators

Although this provision has not yet been implemented, it is quite significant, particularly to other urban regions that anticipate provision of special services into the suburbs. It can be expected that vehicle productivity rates in low density areas will be considerably less than those obtainable in the central city.

The use of taxis in these areas can reduce the vehicle-per-hour costs dramatically. In Cleveland's case, the taxi hourly costs are about one-half the RTA vehicle-hour costs with regular drivers and two-thirds of the RTA costs with the lower paid CRT operators.

CONCLUSIONS

In conclusion, what has been demonstrated in Cleveland is a process by which a large American city has been grappling with the "elderly transportation problem" and has carved out at least a tentative solution based on their needs, their resources, and their political constraints. This was a major test of whether a transit operator, oriented through years of fixed-route, conventional operations, could adjust its organizational structure, its operational procedures, its financial arrangements, and its union work rules to provide a radically different type of service. The major adjustments worthy of attention by other cities are the development of the new labor category and pay scale and the ability to subcontract work to the taxi operator.

REFERENCES

1. Final Evaluation Report, Cleveland Neighborhood Elderly Transportation Project, August 1976.

Appendix A, RTA Policy Statement
Appendix B, Labor Agreement

2. Dial-A-Bus NET Interim Report, City of Cleveland, March 16 - December 31, 1975.

3. Quarterly Report, City of Cleveland, January 1 - May 7, 1976.

APPENDIX Q

NAUGATUCK TRANSIT SERVICE FOR THE HANDICAPPED AND ELDERLY

PROJECT OVERVIEW

A multifaceted experimental demonstration with special emphasis on the handicapped and elderly has been operational in the Lower Naugatuck Valley of Connecticut since January 1973. The system has included limited fixed-route service, demand-responsive service over a wide area, subscription service, and contract bus service for social service agencies and other groups in the Valley. An automated fare collection system, which uses credit cards and monthly billing to eliminate the need for cash payment has been operational over much of the period, although it is temporarily not in use. While additional fare recorders and associated computer hardware and software are being obtained, fare subsidization of agency-sponsored handicapped and elderly citizens is facilitated by a computerized system which bills sponsoring agencies according to use of the service by their clients during the previous billing period. Other concepts tested by the Valley Transit District include new vehicle types and coordination of agencies requiring transport service.

The major component of the project funding has been UMTA demonstration grant CT-06-003, which has the following breakdown:

July 71 - June 74	Cost	Percent
US Dept. of Transportation (UMTA)	$635,000	90
State Dept. of Transportation (Connecticut)	27,750	4
Local Municipalities ($10,000 each)	40,000	6
Total Grants	$692,750	100
June 74 - June 77	$494,500	100
Total	$1,187,250	

An UMTA capital grant totaling $376000 was approved in June, 1974, for the purchase of new vehicles. A further grant was approved in 1976 for the construction of garage,

administrative, and multi-modal passenger terminal facilities. The State of Connecticut is contributing $50,000 and the New England Regional Commission $100,000 to the terminal. Throughout the UMTA demonstration, there has been a simultaneous demonstration under HEW funding and administered by the Lower Naugatuck Valley Community Council. The HEW project was designed to distribute funds directly to agencies and individuals through the automated billing system and to analyze the agency and client impacts of Valley Transit District (VTD) operations. The funding for the HEW project has been:

<u>July 72 - June 74</u>	<u>Cost</u>
US Department of Health, Education and Welfare	$298,000
<u>July 74 - June 75</u>	
US Department of Health, Education and Welfare	154,000
<u>July 75 - October 76</u>	
US Department of Health, Education and Welfare	150,000

This HEW funding has come from a multiplicity of internal HEW programs. This coordination of diverse funding sources for elderly and handicapped transportation is one of the chief areas of interest in the project.

Finally, VTD has received operating assistance from the State of Connecticut in the period June 1974 - June 1976, totalling approximately $165,000. The basic State policy is to reimburse 40% of the operating expense and 50% of any remaining deficit. The entire deficit is submitted by the State to UMTA for 50% reimbursement, which is then used to partially defray State contribution to VTD. To obtain the Connecticut assistance, the four towns in the Valley were required to contribute $37,750 in funding for 1974-77. Thus, the net project cost to date from all sources has been approximately $3.2 million.

The final year of this six-year demonstration program (July 1976-June 1977) includes modifications to the automated billing system, expansion of hours of service to include evenings and weekends, additional vehicles, computer-aided dispatching, and other minor changes. The system has already made most of the necessary adjustments in

service and funding to continue beyond the end of the demonstration grant in June 1977.

PROJECT OBJECTIVES

The project is directly relevant to the Service and Methods Program objective of improving transit service for the handicapped and elderly. The final year of this demonstration seeks to better integrate services to the general public with the target population services, thus meeting the transportation needs of each group more efficiently than if each were served separately. The VTD system thus addresses the objective of transit productivity as well.

An additional local objective is to provide public transit service which can effectively meet the transportation needs of health and social service organizations.

Key issues being examined in this demonstration include comparisons of a variety of services (fixed-route, route-deviation, contract, demand-responsive and subscription) being offered in an attempt to meet the varying needs of different groups in the community, and the effect of VTD service on the mobility and welfare of elderly and handicapped groups.

PROJECT DESCRIPTION

The Valley Transit District currently provides four types of service:

Fixed Routes. Regularly scheduled buses operate Monday through Friday during the offpeak hours of 9:30 a.m. to 3:00 p.m. on a single route in each of the four towns (Seymour, Derby, Ansonia, Shelton) served by VTD. In addition, there is a fixed route operating hourly from 10:00 a.m. to 5:00 p.m. connecting the four towns. The fixed routes are allowed to deviate from the normal path to serve door-to-door and contract passengers whose trips coincide closely with the route. The base fare is $0.50 ($0.25 for ages 6-18 and over 60).

Door-to-Door. A two-hour advance notice telephone call to the VTD dispatcher is required for door-to-door service anywhere within the four-town area. The VTD dispatcher handles calls from the riders, schedules the pickups and

communicates with the drivers on a two-way radio. Demand service is available Monday through Friday, 6:00 a.m. to 6:00 p.m. Patronage of this service is primarily elderly and handicapped users. Total ride cost is based on the length of each ride, and varies from $0.75 to $5. The average fare is $0.88.

Contract Services. Daily or weekly door-to-door pickup and delivery services are available to Valley senior centers, health and social service agencies, and elderly housing. The service is arranged by social service agencies with VTD, and resembles charter bus service in its operation. Contract service is generally a many-to-one operation, although some flexibility in scheduling trips to transport clients to more than one agency is being encouraged in the final year of the demonstration. VTD charges this service on a bus-hour basis with the agency and HEW currently each picking up 50% of the cost. Contract service is available Monday through Friday, 6:00 a.m. to 6:00 p.m., as well as on a limited basis on evenings and weekends.

Subscription Services. Standing orders for service at the same time to and from the same address daily are also handled by the VTD system, either on separate trips or jointly with the door-to-door demand service. This service is tailored for school and work trips, as well as fixed health or social service trips for the target population. The fares are the same as for the demand-responsive, door-to-door service. A monthly pass program is available as well, with users still billed monthly.

The equipment for the project has varied considerably, and now includes 17 vehicles (not all operational), 10 being in service over the day. These are drawn from a fleet of 8 Grumman buses, six Twin Coach vehicles, two vans, and an automobile. Each bus is equipped with a special lowered front step to assist the elderly or slightly handicapped persons in boarding and leaving the bus. Three vehicles have a hydraulic lift to accommodate wheelchair riders. Each of the buses has been equipped with special FAIRTRAN[1] fare boxes that are used in conjunction with the billing system. The fare system, one of the features which makes VTD unique, is a credit card system called FAIRTRAN. It consists of two elements, one of which is a service recorder which is carried on the bus in place of a farebox, and which records the data from a rider's computer credit card (the

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[1]FAIRTRAN is the registered trademark of RRC International.

Low, Wide Steps Provide Ease of Boarding,
Naugatuck Valley, Connecticut

"V-card," required to use most VTD services), and other pertinent information (time of day, origin point, etc.) on a magnetic tape cassette. The other component is the computer software required to transform the records into monthly billings (post-payment). The special feature of FAIRTRAN is the FARESHARE option. This feature is paramount to the system because it allows third parties (health and social service agencies, governmental agencies) to share in the cost of an individual's transportation to varying degrees, thus enabling a person to make trips he or she might otherwise be unable to afford. The FAIRTRAN system is not currently operational, although the third-party billing has been continued on a manual accounting basis. FAIRTRAN is scheduled to be re-introduced in early 1977 when additional service recorders for the expanded fleet will be available, and new computer hardware and revised software will be incorporated into the FAIRTRAN recording and billing system. At that time general riders will be able to pay cash for their trips or use their V-card and receive a monthly billing. Fare-sharing subsidies are only available if a rider uses the V-card, thus encouraging card use rather than cash payment by those eligible for subsidies, such as persons over age 65. In general, V-card use will be encouraged over cash.

The service area for the door-to-door, contract, and subscription services is relatively large (59 square miles) to serve with a limited fleet. The entire area population is approximately 73,700, of which 8,500 persons are handicapped, 6,500 are elderly, and 3,500 are low income (there is some overlap among these target groups). The agencies served by VTD are also dispersed throughout this area: senior centers in each of the four towns, VARCA (Valley Association for Retarded Children and Adults), two hospitals, the YMCA, Girl Scouts, Boys's Club, a day care center, several housing authorities, health agencies and others. VTD is restricted by the Connecticut PUC to operate solely within the boundaries of the Valley, and thus trips to nearby centers such as New Haven, Bridgeport, and Waterbury cannot be served.

History and Status

Limited intra-Valley public transportation was available to the residents of the Naugatuck Valley District before the Valley Transit District service was initiated. Private bus transportation is provided by two companies: The Connecticut Company (now State-owned) and the Valley Transportation Company. The Valley also has a taxi service

operating primarily between the business districts of Ansonia, Derby, and Shelton. Neither the taxi service nor the bus companies provide specific service to health and social agencies.

Initiation of the Valley Transit Project dates back approximately seven years when several agencies under the United Fund of the Lower Naugatuck Valley submitted a proposal for the funding of a transport program for the disabled and disadvantaged. In 1971 UMTA agreed to fund the Valley Transit District, which was created by special act of the Connecticut State Legislature in the same year. The VTD was created specifically for the administration of the UMTA demonstration project, but its powers and scope go beyond just the demonstration. The VTD is controlled by a Board of Directors appointed from the four towns in the Valley.

The project is characterized by three phases: Phase 1 (December 1972 - March 23, 1973), Phase 2 (March 23, 1973 - July 1974), and Phase 3 (July 1974 - June 1977).

Phase 1 - December 1972 - March 23, 1973

Initiation of service slipped from June 1972 to December 1972 due to late delivery of the modified vehicles. Service was inaugurated in December 1972 upon the arrival of the first four 21-passenger buses (equipped with a special front step). The inaugural service consisted of a free Christmas shopping shuttle under the sponsorship of the Valley Chamber of Commerce. Starting in January, VTD operated a fixed-route service filling a gap in service created by a strike of the two private bus companies which extended through the duration of Phase 1. This service was made available to all Valley residents. Contract service was also begun in January 1973. The fixed route was dropped when the strike ended in March 1973.

Although FAIRTRAN was not yet in operation, registration for FAIRTRAN service and the issuance of V-cards began during Phase 1. Registration for the FAIRTRAN service was open to all Valley citizens.

Phase 2 - March 23, 1973 - July 1974

Phase 2 marked the beginning of the FAIRTRAN operation and the many-to-many demand services. Due to demands for service that outstripped available capacity, the Valley was divided into five subareas, each being served only once a

week by the demand service. The residents in each sub-area, however, could travel throughout the Valley on the days that they used the service. The subscription and the contract services and emergency medical trips were not limited by the subarea policy.

In July 1973, due to the rapid growth in demand for the demand services, the VTD decided to limit further issue of V-cards to only the handicapped and elderly citizens. By mid-February 1974, the demand services were again saturated, and the VTD decided to discontinue further issuance of V-cards.

One of the reasons for the quick saturation of the demand service capacity was the extensive use of the buses for contract services. Contract service consumed 50 percent of the total vehicle hours and generated two thirds of the system revenue by March 1974. Extensive equipment failures also limited the overall capacity of the system.

Phase 3 - July 1974 - June 1977

The Valley Transit District, in the spring of 1974, made application to the Federal government for two grants. The first was a capital grant for the purchase of nine additional buses, and the creation of a storage and maintenance facility for the buses. The second grant application was for continuation of the demonstration grant for another three years. In addition, the Valley Transit District entered into a contract with the State of Connecticut for reimbursement of 50% of all operating deficits for a period of one year.

However, as a prerequisite, the Transit District was informed that it would have to show evidence of local financial involvement in the project, and furthermore, show that it was operational as of the first of July. Because of extraordinarily high maintenance and repair costs for the vehicles and extremely high down time for the vehicles which resulted in reduced revenues, the initial demonstration project which was designed to run through June of 1974 had exhausted its funds by the end of March 1974. In order to operate for the interim period and show local financial involvement, the VTD first requested funds from the four municipalities. This request was turned down by all the municipalities. Then, the VTD, consistent with its statutory authority, voted to levy a \$0.01 per gallon gas tax on the sale of all gasoline in the four Valley municipalities. If the towns would grant VTD \$0.50 per

capita, however, the tax would be rescinded. This did occur, and the gas tax was never imposed at the pumps. The Federal grants were approved.

The summer and fall of 1974 saw large changes in the VTD operation. At one point only two of the original six vehicles were operable, causing extremely unreliable and limited service. School buses, vans, and autos were leased to bridge the equipment gap. In summer of 1974, all subareas in the Valley were again serviced daily once the vehicle fleet permitted. The director and all but one of the members of the VTD Board of Directors resigned, and were replaced by new members.

Eight new vehicles were received in October 1975. In November 1975, the fixed route service in and between the four towns was begun. Contract, demand, and subscription services have been continued without interruption, and have been expanded as equipment was acquired. Equipment reliability has increased, and the system is now operating without leased vehicles and providing a reliable service level.

During the entire demonstration, the Lower Naugatuck Valley Community Council (LNVCC) has acted as a "broker" of VTD services, assisting agencies in obtaining VTD services for their clients and their activities, resolving service problems, etc. In addition, LNVCC has played the role of coordinating and pooling the transportation components of a whole host of HEW programs to provide the user-side subsidy of VTD users. One of the large institutional hurdles that had to be overcome by LNVCC was to convince the various HEW programs to "buy a piece of VTD," rather than to purchase vehicles for the separate use of each program's target group.

Planning is also currently underway to develop a multi-modal transportation terminal for the Valley. This will be located on the same site as the VTD offices and maintenance facility, which will bear the majority of the cost. This facility will be serviced by interstate buses, the rail connection between Waterbury and Bridgeport, the airport limousines and all linked together by the door-to-door service of the Valley Transit District, as well as its fixed routes.

TABLE Q-1. SELECTED RESULTS: TRANSIT SERVICE FOR HANDICAPPED AND ELDERLY, VALLEY TRANSIT DISTRICT, CONNECTICUT

Category		
COSTS:		
Total Capital and System Development July 1974-June 1976		$1,276,000
Annual Operating Costs July 1975-June 1976	Approx. $	312,000
RIDERSHIP AVERAGES:		
Average Weekly Ridership July 1975-June 1976		
User Group:		
Elderly/handicapped		2,600
General public		200
Total Average Weekly Ridership		2,800
FARE STRUCTURE/REVENUE:		
June 1976		
Contract Service Rate		$14.00 per hr.[1]
Average Demand Round Trip Fare		$ 0.88
Operating Ratio (Oper. Rev/Cost)		$ 0.53
Annual Revenue July 1975-June 1976	Approx. $	161,000
PRODUCTIVITY:		
June 1976		
Passengers/Vehicle-hour		5.9
UNIT COSTS:		
June 1976		
Operating Cost/Passenger Trip		$ 2.07
Operating Cost/Vehicle-hour		$12.21
Operating Cost/Vehicle-mile		$ 0.91
OPERATIONS LEVEL:		
June 1976		
Total Bus Hours (one month)		2,025
Total Bus Miles (one month)		29,966
Average speed		13.6 mph

[1]Fifty percent paid by agency and 50% by HEW grant.

FINDINGS

Table Q-1 summarizes the current results of the VTD demonstration. Weekly ridership is near 3,000 trips and productivity averages near 6 passengers per vehicle-hour over all services. The contract and subscription services have the highest productivities, sometimes reaching 20 passengers per hour. The demand and fixed-route services generally have productivities lower than the system average. Over 3,000 V-cards have been distributed but there were applicants denied registration due to the limited system capacity. V-cards are not required for VTD contract services, though, so the number of individuals that have utilized VTD service exceeds 3,000. Detailed breakdowns of ridership by service type are not available, but the bulk of ridership (perhaps 2/3) is still generated by the contract services, followed by subscription and demand services at lower levels, and finally by fixed route service.

Since the contract services are the dominant mode of operation, trips to social service agencies are the main trip purpose served by VTD. Subscription users are primarily using the system to travel to work, while the demand and fixed-routes serve a variety of trip purposes.

The demonstration was severely hampered by mechanical problems for its first three years; these have largely been overcome at this point, but only at a very large expenditure in maintenance and rebuilding costs. VTD currently employs three mechanics on a full and part-time basis to maintain its 17-vehicle fleet; the vehicles also absorb a large proportion of the administrative effort of VTD in dealing with the manufacturer, with agencies and clients affected by equipment failures, etc.

In spite of these and other difficulties, the system has managed to achieve a 50-55% revenue/cost ratio (including user-side subsidy) which, when coupled with the demonstration grant and the State of Connecticut operating assistance program, allows it to operate without local funding. This is a key to its viability in the Valley and thus VTD has effectively achieved the transition from demonstration to regular operating status.

The LNVCC has successfully assembled over $602,000 in HEW funds from various programs in the period July 1972 - October 1976, which have paid for both user-side subsidies and consultant services in planning the VTD system. The LNVCC has also been the transportation broker for the VTD agency users shown in Table Q-2, working to coordinate

TABLE Q-2. TRANSPORTATION USE BY SELECTED AGENCIES (1974)

	Use/Week (Round Trip)	Passenger Trips/Week	Total Annual Cost
Social Service Agencies			
VARCA[1]	15	450	$16,000
LNV Daycare Center	5	100	4,000
Girl Scouts	very little	---	---
Shelton-Derby Boys' Club	1	40	---
Ansonia Senior Center	2-3	70	5,000
Derby Senior Center	2	60	4,000
Seymour Senior Center	2	60	5,000
Shelton Senior Center	2	100	4,500
YMCA	1	44	100
Housing Authorities			
Father Callahan	1	42	800
Stygar Terrace	1	42	800
Health Agencies			
American Red Cross	1	60	480
Griffin Hospital	door-to-door	75	2,500
Hewitt Hospital	very little	---	---
Homemakers	door-to-door	50	2,000

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[1]Valley Association for Retarded Children and Adults.

agencies' needs with VTD capabilities to ensure the efficient provision of transportation services. As shown in Table Q-2, VTD has succeeded in serving a wide range of agency needs in the Valley with a single system.

IMPLICATIONS

The Valley Transit District is an operating model of an elderly and handicapped transportation service, utilizing door-to-door service in contract and demand (call-in) modes, third-party billing for user-side subsidies, and coordination of varied social and health program funding sources to support the system. Service to the general public is gradually being expanded and integrated where it can provide needed services to a clearly identified market (e.g., school trips, home-to-work) and raise the operating (revenue/cost) ratio of VTD, but the target groups receive first priority for service.

The FAIRTRAN computerized billing system facilitated the third-party billing system while it was operational, but manual billing has functioned satisfactorily as well, although it is much more time consuming. The dispatching system currently in use is also a manual system based on sorting slips containing ride information into slots representing vehicle tours; this again has proved satisfactory for the 10-vehicle system, although some computer-aided dispatching capabilities will be added in early 1977.

A large portion of VTD's continued existence after its near-shutdown in 1974 has to be credited to a great deal of VTD management attention to the basic elements of providng service: keeping the vehicle fleet operational, matching the services offered to local needs based on close contact with agencies and users, and the direction of new service capacity (above that required for basic target group service) into markets that produce high revenue/cost ratios to enhance system economics. Little effort has been expended on advanced dispatching, communications, or service policies. Effort was expended early in the project to improve available vehicle designs to accommodate the elderly and handicapped with a high comfort level; these design modifications have helped to set national standards for barrier-free equipment.

Several site characteristics in the Valley may affect the transferability of this demonstration's results to other areas:

- The Valley is a small region, thus making institutional cooperation (VTD, LNVCC, VRPA) easier than in larger regions.

- Conventional transit is relatively limited in the Valley.

- VTD is restricted from serving trips beyond its boundaries, strongly limiting its ability to provide all needed services to its target population, and restricting its revenue potential as well.

- VTD operating costs reflect a relatively low driver wage rate of $3.00 per hour.

- VTD serves a large, relatively low-density area, thus limiting its vehicle productivity on most trips.

However, the basic findings of the VTD demonstration on how to operate the system should remain basically unchanged in spite of these variations.

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APPENDIX R

MOUNTAIN VIEW COMMUNITY BROKER DEMONSTRATION PROJECT

OVERVIEW

The Community Services Cooperative (CSC) Project in Mountain View, California (CA-96-0002), is a test of the "community broker" concept in which a broker aggregates elderly and handicapped travel demand on a pre-scheduled, shared-ride basis. The broker also acts as an organizer of human services for his clients so as to aggregate travel demand (to those services) in the most efficient way possible. Transportation is provided in either standard five-passenger taxi vehicles or an eleven-passenger van driven by the broker. Both the standard taxi rides and rides via the van and driver/broker are provided by the local taxicab company: taxicab rides are arranged by the broker, but otherwise provided in the traditional manner; the van and driver are leased to the project from the cab company. It will be determined whether such travel can be provided at a low cost to users (on a shared-ride basis) and at the same time be economically self-sufficient, paying all costs solely from fares generated.

The target population at present are the handicapped and elderly who live in two apartment complexes approximately one mile from each other; one intention of the experiment is to determine the size of the geographical market that must be served to generate sufficient demand for high productivity and to test the workability of the system to coordinate rides within that geographical market.

There are several "broker" concepts that are being discussed and tested within the public transit field. The CSC test is one in which an individual works very closely with a selected group of consumer clients and actually acts as van driver and escort. Other cases (e.g., in Knoxville, Tennessee) test what could be called an "institutional broker" concept, whereby an individual broker coordinates all possible transportation resources and many different consumer client groups (e.g., workers, employers, handicapped, elderly, youth) in a large setting.

Funding and Sources

Federal (Joint HUD-UMTA)	$152,675
State	-0
Local	-0-
Total	$152,675

Timing

Date of Grant Award:	7/75
Actual Start Date:	2/16/76
Planned Termination Date:	12/31/76

OBJECTIVES AND EVALUATION ISSUES

The SMD objectives covered in this demonstration are:

- Increasing transit coverage
- Increasing transit vehicle productivity
- Improving service for the transit-dependent (i.e., the handicapped and elderly, primarily of low income)

The relevance of the project to the first two SMD objectives cited above is, to a large extent, subsumed under the primary objective of improving service for handicapped and elderly persons. However, in reality, the demonstration must attempt to balance all three objectives. Thus, while its intent is to serve as an improvement in public transportation for special transit dependent groups, it attempts to do so through grouping of rides--causing greater vehicle productivity and creating the economic conditions such that a new market (subsidized or nonsubsidized) is created for paratransit suppliers.

Locally, the project is aimed at solving two inter-related problems:

- The high cost of suitable public transportation for meeting the transportation needs of low-income

Broker/Driver Acts as Escort for Elderly,
Mountain View, California

Community Services Cooperative Provides Shared-Ride, Pre-Scheduled Van Service to Shopping Center, Mountain View, California

and mobility-impaired elderly and handicapped persons.

- Poor utilization of community human services by these persons, particulary due to lack of adequate means of transportation.

A fixed-route bus system often provides inadequate service for the handicapped and elderly; publicly operated dial-a-ride systems which provide more adequate service are usually too expensive for local jurisdictions to subsidize; and taxicabs are too expensive for most users. Consequently, the main objective of this project is to test whether or not a stable market for low-cost, pre-scheduled group rides serving many of the transportation needs of the target groups can be created and sustained through an adaptation of the consumer cooperative mechanism.

The key issues to be examined are:

- Viability of brokering small group taxi rides
- Viability of brokering larger group van rides on a self-supporting basis
- Impact of the project on the travel behavior of users
- Unit cost for transportation under the project and how it compares to alternative transportation options
- Impact on coordination and use of human services by clients.

PROJECT DESCRIPTION

The project is currently operating in two sites. At the first site (Central Park Apartments in Mountain View), the community broker is driving and offering his clientele organized trips in an 11-passenger van. At the second site (Palo Alto Gardens in Palo Alto), the community broker initially offered her clientele only group rides in taxis provided by Cabs Unlimited of Mountain View, with the full cost of the ride being shared among the riders. After the initial six week experiment, van service was expanded to the second site with only one broker/driver serving both communities.

The broker/driver is an employee (through lease arrangements) of Cabs Unlimited and operates from space allocated to him in the lobby of the Central Park Apartments. He has the use of bulletin boards and leaflets members in both apartment complexes. Schedules are distributed every two weeks. The broker's phone is answered by a 24-hour answering service in the event the broker is not at his desk.

The community broker's primary functions are:

1) to recruit members,

2) to organize ride schedules,

3) to coordinate with service agencies,

4) to broker the market to suppliers of transportation in certain cases, and

5) to provide escort and act as the vehicle driver in other cases.

The goals of the community broker are:

1) to aggregate present individual needs for transportation by the client population and, when desired by the client population, to enrich their trip-making capabilities,

2) to decrease the costs of transportation to the client population through group sharing of trip costs,

3) to pay for the cost of the brokerage function through increased productivity created by group riding,

4) to provide an informational and referral role for the clients, social service agencies, and transportation suppliers, and

5) to effect savings on the part of social service agencies which provide transportation and other services to the client population.

Fares are established according to trip costs and the number of riders. In the case of brokered taxi cab rides, the regular metered fare is split among the riders; no brokerage fee is added (see Figure R-1). In the case of the

	INDIVIDUAL FARES			
TOTAL FARE	2 RIDERS	3 RIDERS	4 RIDERS	5 RIDERS
1.50	.80	.50	.40	.30
1.60	.80	.60	.40	.40
1.70	.90	.60	.50	.40
1.80	.90	.60	.50	.40
1.90	1.00	.70	.50	.40
2.00	1.00	.70	.50	.40
2.10	1.10	.70	.60	.50
2.20	1.10	.80	.60	.50
2.30	1.20	.80	.60	.50
2.40	1.20	.80	.60	.50
2.50	1.30	.90	.70	.50
2.60	1.30	.90	.70	.60
2.70	1.40	.90	.70	.60
2.80	1.40	1.00	.70	.60
2.90	1.50	1.00	.80	.60
3.00	1.50	1.00	.80	.60
3.10	1.60	1.10	.80	.70
3.20	1.60	1.10	.80	.70
3.30	1.70	1.10	.90	.70
3.40	1.70	1.20	.90	.70
3.50	1.80	1.20	.90	.70
3.60	1.80	1.20	.90	.80
3.70	1.90	1.30	1.00	.80
3.80	1.90	1.30	1.00	.80
3.90	2.00	1.30	1.00	.80
4.00	2.00	1.40	1.00	.80
4.10	2.10	1.40	1.10	.90
4.20	2.10	1.40	1.10	.90
4.30	2.20	1.50	1.10	.90
4.40	2.20	1.50	1.10	.90
4.50	2.30	1.50	1.20	.90
4.60	2.30	1.60	1.20	1.00
4.70	2.40	1.60	1.20	1.00
4.80	2.40	1.60	1.20	1.00
4.90	2.50	1.70	1.30	1.00
5.00	2.50	1.70	1.30	1.00
5.10	2.60	1.70	1.30	1.10
5.20	2.60	1.80	1.30	1.10
5.30	2.70	1.80	1.40	1.10
5.40	2.70	1.80	1.40	1.10
5.50	2.80	1.90	1.40	1.10
5.60	2.80	1.90	1.40	1.20
5.70	2.90	1.90	1.50	1.20
5.80	2.90	2.00	1.50	1.20
5.90	3.00	2.00	1.50	1.20
6.00	3.00	2.00	1.50	1.20
6.10	3.10	2.10	1.60	1.30
6.20	3.10	2.10	1.60	1.30
6.30	3.20	2.10	1.60	1.30
6.40	3.20	2.20	1.60	1.30
6.50	3.30	2.20	1.70	1.30
6.60	3.30	2.20	1.70	1.40
6.70	3.40	2.30	1.70	1.40
6.80	3.40	2.30	1.70	1.40
6.90	3.50	2.30	1.80	1.40
7.00	3.50	2.40	1.80	1.40
7.10	3.60	2.40	1.80	1.50
7.20	3.60	2.40	1.80	1.50
7.30	3.70	2.50	1.90	1.50
7.40	3.70	2.50	1.90	1.50

TIPPING CAB DRIVERS IS RECOMMENDED - PLEASE USE COINS, NOT COUPONS.

FIGURE R-1. CSC TAXI FARE-SPLITTING TABLE

van operation, it was necessary to institute a whole new fare schedule.

Initially, a zone based "fare splitter" was designed to approximate trip costs in the van on the basis of trip distance (Figure R-2). The schedule was designed to interface, in a graduated sense, with shared taxicab rates for smaller than five-person group rides. There is a continuum of the amount of user fare savings from small to large group rates, with a larger vehicle taking over for a smaller vehicle when the group has five or more persons.

It is thought by the project staff that there is a threshold in terms of what the client population served is willing to pay for this type of ride (i.e., prescheduled, door-to-door). That threshold is felt to be around $.50 per one-way trip. For taxicab rides, the full fare for most trips (even short ones) exceeds $2.50. Thus, it can be seen from Figure R-1 that passenger fares (even with five persons sharing the cost) would exceed the threshold in practically all cases. In the case of the van operation (Figure R-2), 75% of the instances cited would fall at the threshold or below. This not only has its consequences for demand but also for the cost of transportation to the clients themselves.

For initial advertising and promotional purposes, CSC members were given $3 worth of coupons at the time of registration for use on taxis or in the van. A plan for "loss leaders" in the case of the van (i.e., trips with fewer than five riders scheduled) was not implemented due to the concerns on the part of the clients who thought that such trips were a waste of the broker's time unless the few scheduled passengers wanted to pay the full fare. In addition, a considerable amount of planning and coordination went into the initial scheduling so as to guarantee that most trips would have five or more persons signed up for a trip.

Another type of problem arises when persons signed up for a ride either cancel or do not show up at the last minute. In this case, clients can literally be ready to go, inside the taxi or van, expecting to pay a fare based on scheduled occupancy, not on lower, actual occupancy. Alternatively, extra riders can show up at the last minute and theoretically cause a recalculation of fare per passenger.

In all such cases involving the vans, the operating policy has been to charge fares on the basis of the original

NUMBER OF PASSENGERS	ZONE 1	ZONE 2	ZONE 3	ZONE 4
5	40¢ (T=$2.00)	60¢ (T=$3.00)	80¢ (T=$4.00)	$1.00 (T=$5.00)
6	40¢ (T=$2.40)	50¢ (T=$3.00)	60¢ (T=$3.60)	90¢ (T=$5.40)
7	30¢ (T=$2.10)	50¢ (T=$3.50)	60¢ (T=$4.20)	80¢ (T=$5.60)
8	30¢ (T=$2.40)	40¢ (T=$3.20)	50¢ (T=$4.00)	70¢ (T=$5.60)
9	30¢ (T=$2.70)	40¢ (T=$3.60)	50¢ (T=$4.50)	60¢ (T=$5.40)
10 & 11	20¢ (T=$2.10)	30¢ (T=$3.15)	40¢ (T=$4.20)	50¢ (T=$5.25)

(T=Total Fare for all Passengers)

ZONE 1 INCLUDES TRIPS FROM CENTRAL PARK TO MV RECREATION CENTER, ALPHA BETA AND MAYFIELD MALL

ZONE 2 INCLUDES TRIPS FROM CENTRAL PARK TO THE ADOBE BUILDING, CASTRO STREET AND SAN ANTONIO CENTER

ZONE 3 INCLUDES TRIPS FROM CENTRAL PARK TO EL CAMINO HOSPITAL, DOWNTOWN LOS ALTOS AND MV SHOPPING CENTER

ZONE 4 INCLUDES TRIPS FROM CENTRAL PARK TO STANFORD HOSPITAL AND DOWNTOWN PALO ALTO

FIGURE R-2. ZONAL FARE STRUCTURE

scheduled occupancy. If the actual occupancy at the time of the ride has fallen to below five passengers, the broker and the riders collectively made a decision as to how important it is for the ride to be make, despite low occupancy. In many cases, the clients are very dependent on the ride at that time and the trip takes place. Thus, it is necessary for the broker, in working with his clients over time, to insure that there is as much congruence as possible between scheduled and actual occupancy. There is no such flexibility offered in the case of taxicab rides where actual riders pay the full fare or cancel the ride.

After the first four months of the project, many of the van rides became regular ones with fairly constant occupancy rates. In these cases, the broker and clients became accustomed to using a flat fare. In other cases, the fare splitter has continued to be used.

The basic economic question revolves around the issue of whether or not the community broker can serve a large enough client population to maintain a full schedule of rides and thereby generate sufficient revenue to pay for the cost of the transportation and brokerage functions together.

In the case of brokering unsubsidized taxicab rides (five or fewer passengers), there is little expectation that income to the broker can be leveraged out of the total revenue generated. This is basically due to the high costs of taxi rides and the limited number of passengers who can share the cost. At best, such brokering may only be a "good faith" gesture toward the clients and the taxi providers - in those cases where a van ride is not justified by low demand for a particular trip and where users are willing to share the cost of a taxi trip. Such brokering activity would undoubtedly have to be subsidized. However, the project staff was committed to testing the concept of brokering such taxicab rides and did so, exclusively, in one of the two sites for a six-week period of time (Palo Alto Gardens in Palo Alto).

In the case of brokering unsubsidized van rides (five to eleven passengers), there is more opportunity to leverage income to the broker out of the total revenue generated, and, at the same time, provide a highly needed, low-cost transportation resource to the client population. This, in effect, is the key economic element being demonstrated and tested in the CSC project.

Site Characteristics

The demonstration is taking place in Mountain View and Palo Alto, California; both communities are in Santa Clara County and are about 40 miles south of San Francisco. The two specific sites for the project, to date, are two low-income (HUD 221) apartment complexes with approximately 160 residents each: Palo Alto Gardens and Central Park Apartments. The project may expand to neighborhoods contiguous to the two complexes, which are about one mile apart. Additionally, other nearby sites are being investigated for possible expansion.

Eighty-five percent of the target population in the two apartment complexes live alone; the other 15% live in two-person households. Approximately 80% of the household incomes are below $5,000 a year; 18% are between 5,000 and $10,000; only 2% are over $10,000. Approximately 40% of the target persons are drivers and have use of a car; the other 60% are dependent on public transportation, social service agency transit, and rides from friends and relatives.

Before this project, only two public transportation alternatives were available in most parts of Santa Clara County. An arterial bus system of 200 vehicles serves an area and population which is as large as a region on the other side of the San Francisco Bay which is served by 900 vehicles. Therefore, the routes are limited, headways are often 30 minutes or even an hour, and buses are frequently late. Taxicab service is available but costly, averaging between $3 and $6 per one-way trip. The City of Palo Alto, through Project Mobility, provides a subsidy for senior citizens and handicapped persons who are classified as low-mobility poor. This subsidy program is available to some residents of Palo Alto Gardens. In addition, during the first month of the project, two bus routes were changed to include stops at Palo Alto Gardens. There is no comparable doorstep bus service to Central Park Apartments in Mountain View.

HISTORY AND STATUS

The project had been in the design and planning stages for several years within the Department of Engineering-Economic Systems of Stanford University. The implementation contract was awarded in July 1975, and operations began on February 15, 1976.

The results of the first six weeks of operation were reviewed in April and the following project modifications were made:

1. The operation at the Palo Alto Gardens Apartment Complex, in which the community broker organizes only shared-taxi rides with no subsidy in standard five-passenger taxis, would be de-emphasized in favor of expanding the van operation.

2. The operation at Central Park Apartments, in which the community broker acts as broker and driver of a van under contract with the local taxi provider, would be expanded to contiguous areas including Palo Alto Gardens, a nearby trailer court, and nearby single-family houses.

It has taken four months for the project staff to gain acceptance of the taxi operator for this service expansion plan. Thus, expansion is to begin during September 1976.

At the same time, the project staff has reviewed various options and combinations of pricing structures and subsidy arrangements negotiated between the project and other human services agencies. The "fare splitter" mechanism is evolving into a flat fare policy for repeat rides with known origins/destinations and stable rider occupancy. In addition, by raising fares, the average revenue per passenger is being raised to more accurately reflect costs of broker/driver time per vehicle trip. A senior citizen nutrition program has negotiated a separate contract with the project whereby their clients will be provided transportation to their meal program. Not all of the clients are regular members of the CSC Cooperative, but live close enough to the van operation to be efficiently served. In addition, the project has negotiated trips to a local medical clinic on the part of transient clients. The project staff interprets this type of expansion as an efficient use of resources which supports the basic economic viability of the van service to its regular members who are not, as yet, fully using all of the available van time.

FINDINGS

Brokering of Standard Group Taxi Rides

The results of the experiment at Palo Alto Gardens, i.e., the brokering of standard group taxi rides, indicate that the concept, in this context, is not a useful or viable

one. After six weeks of operation, 27 members made a total of only eight group taxi trips, although several more were canceled for lack of a full load and many more were proposed to members without success.

Part of the low market penetration can be attributed to poor working relations between the project staff and the management of the apartment complex. At the same time, additional regular bus transit service was being added to that site, which also enjoys a slightly higher availability of cars than at the other site.

However, the basic transit service product being offered by the project was not of sufficient quality to compete with the alternatives available. Brokering of taxi rides suffer the following disadvantages:

1) The broker is not available as escort and, thus, cannot act as a buffer between particular elderly persons who may not be used to sharing activities with one another; this tends to diminish the attractiveness of the ride to the clients, therefore diminishing demand.

2) The high cost of an unsubsidized taxi ride, even if split three or four ways, exceeds the hypothesized threshold of $.50 per passenger, resulting in low demand and leaving little or no leverage for a fee to the broker.

3) The maximum number of persons that can be comfortably served by a five-passenger taxicab in most cases is really only four -- especially when one or more are disabled persons.

4) Organizing a group ride of three or four persons can be almost as time-consuming for the broker as organizing a six or seven person ride.

Thus, in this case, the broker is forever faced with the task of organizing one-shot, time-consuming, low-productivity rides with little leverage for factoring in the cost of his services. Consequently, this type of brokerage is seen as economically self-sustaining only as an adjunct to brokerage of van rides where the broker also acts as driver.

Brokering Group Van Rides

The total brokerage and transportation cost for one driver and van, as negotiated with a local supplier, is $20,875 a year. This breaks down into $9,600 for the broker/driver's salary, and $8,672 for the vehicle, including its depreciation, licensing, and insurance for a maximum of 30,000 miles per year. The remainder is the fee for the supplier (approximately 10%) and fringe benefits for the broker/driver, who is salaried at approximately $5 per hour.

The above lease arrangement was negotiated on a non-competitive, non-fleet basis. The project staff feels that it could be possible to negotiate a $15,000 to $18,000 salary and van lease on a competitive and/or fleet basis. The minimum system performance required in order for the operation to be self supporting is shown in Table R-1.

TABLE R-1

GOALS FOR DRIVER/VEHICLE PRODUCTIVITY (ONE-WAY TRIPS)

Revenue Required	$18,000/year
Average Vehicle Trip Fare	$3/trip
Vehicle Trips Per Year	6,000
Vehicle Trips per 250 Service Days	24 trips/day
Vehicle Trips Required per Hour	3 trips/hour
Average Load Factor	7.5 pax/trip
Average Passenger Trips per Hour	22.5 pax trips/hour
Average Fare per Passenger Trip	$.40

To date, the van has averaged 24 one-way trips per week (or slightly less than five one-way trips a day) on a five-day schedule, for the first sixteen weeks, or a total of 374 one-way trips. The number of passengers has averaged 5.5 per vehicle trip. The broker actually makes one vehicle trip (included above) on Sundays, in addition to weekday service from approximately 9 a.m. to 4 p.m.

Types of trips, in order of frequency, are: shopping (36%), breakfasts (18%), recreation (12%), other meals (12%), and churches (6%).

As for the allocation of the broker/driver's time during this period, it was divided as follows: 18% driving, 30% contacts with members and 17% scheduling. The remaining time was devoted to administration, vehicle maintenance, and

contacts with service providers. Though there was also a significant amount of idle time, it is hoped that further expansion of the market served will eliminate unused time.

Economic data for the first sixteen weeks show that revenue averaged about $1.60 per one-way trip. Revenue per passenger was $.29 per one-way trip. This is about one-half the amounts expected when the operation reaches its full potential. After two months, the van operation was expanded into Palo Alto Gardens; however, little progress has been made in terms of increasing membership or demand from that site. Total project membership from both apartment complexes is 110 and appears to have leveled off.

During the most recent four weeks for which there is data, members average 6.5 one-way trips per person for the four weeks. The 42 members who have ridden the van frequently enough to have a well-founded opinion, responded that they were satisfied with the service. They also responded affirmatively to a series of questions on (a) whether or not the service was dependable, (b) whether or not the broker was helpful, and (c) whether or not there were any particular difficulties. The major suggestions were for (a) more recreational rides, and (b) better steps for the van.

Among the lessons learned from the van operation so far, four might be singled out for comment.

1. The van is proving to be very flexible as a vehicle for personal transit. For one thing, a seat can readily be removed to accommodate shopping carts on shopping trips. With a van, complex round-robin or multi-purpose rides can be arranged and controlled. Also, complex linkages to arterial buses work smoothly with a van and a driver who knows the people who are riding with him well. Further, problems that arise en route can readily be dealt with when the broker is also the driver.

2. The leverage of large numbers, which only a van can handle, is an important element in the system. The difference between a $.50 van ride and a $1.00 group cab ride is, in many cases, a deciding factor on whether or not a low-income person will opt to ride. Conversely, cancellations (which are fairly frequent) perturb the economics of group riding more severely with taxi rides involving a maximum of four people, versus van rides with eight to ten people.

3. The staff has been learning that the development of a new transportation system, particularly for this age and income group, is a slow process. Because there are no pre-existing "mental" models for people to use as a guide, only the more adventurous seem willing to try the system at first. A larger constituency must be created through positive experiences related to potential users by word-of-mouth. Presumably, this problem with the newness of the project will become less important as people become more familiar with the service.

By the same token, the broker has also found that more trial and error than anticipated has been necessary in arranging schedules and communicating with people. Considerable effort has gone into seeing what works and in finding out precisely what each subgroup needs in the way of transportation.

4. From the standpoint of maintaining contact and control, it is clear advantage to combine the driver and broker roles; but the logistics involved in arranging a schedule, signing people up, and controlling the trips themselves have proved to be more difficult than anticipated.

To communicate with members, the staff has been trying various approaches, from telephone calls to bulletin boards, to leaflets in mail boxes, to return cards, to public meetings; but they have not yet fixed on any preferred method.

IMPLICATIONS

Two of the three criteria for measuring the success of the project have substantially been met in terms of van operation at Central Park Apartments. It is (a) workable, and (b) acceptable. The broker will attempt to expand the volume and density of his ride schedule in the coming weeks. Only about 50% of the broker's time is fully utilized at present. Further, as the volume of rides increases, and as a stable schedule of repeat (or subscription) rides crystallize, the broker will be spending a greater overall proportion of his time driving.

As for the economic viability of the system, no firm conclusions can be made at present. The staff estimates that the operation will reach the breakeven point when the total number of registered clientele in the group reaches about 300 (versus 110, currently), when the number of one-

way vehicle trips averages 24 per day (versus 5 at present), when the average number of riders per trip reaches 7.5 (versus 5.5 at present), and when the income from the rides reaches about $360 per week, or $18,000 for a 50-week period.

Several explanations for the less successful results at Palo Alto Gardens are possible. For one thing, there are a greater number of transportation options available to Palo Alto Garden residents. Two new bus routes were established during the first month of the project which stop at the front door. Residents also have access to a taxi subsidy (Project Mobility) usable with a Palo Alto Cab company, distinct from the one participaing in the project. This subsidy, in effect, competes with the community broker service.

In addition, the project staff has never enjoyed a close, cooperative working relationship with a majority of the residents at Palo Alto Gardens. The limited brokering offered at the beginning undoubtedly weakened the impact further.

Now that the project staff has acceptance on the part of the cab company for general expansion in lower density residential neighborhoods, it still remains to be seen what overall impact and efficiency can be gained in the operation.

APPENDIX S

PORTLAND HANDICAPPED AND ELDERLY TRANSPORTATION PROJECT

PROJECT OVERVIEW

The Portland Handicapped and Elderly Transportation Project is a transit-operator-provided, demand-responsive service in an urbanized area of nearly 400,000 people. Demand-responsive service will be designed to provide a basic level of service to handicapped and elderly citizens who are physically unable to use the regular, fixed-route transit system.

This project, operated by the Tri-County Metropolitan Transportation District of Oregon (Tri-Met), will demonstrate the feasibility of having an experienced transit operator provide areawide transportation services to special groups in a medium-sized city. The Portland special transportation project will also demonstrate the coordination of transit and human services agencies. The key social service agency involved is the Bureau of Human Resources of the City of Portland.

In addition, this project will test the usefulness of automated fare recording equipment and computerized third-party billing to social services agencies. The fare recording equipment has been initially tested in another SMD demonstration in the Naugatuck Valley Region of Connecticut and has proved to be operationally practical. This demonstration will test the equipment's cost-effectiveness and value to social service agencies (third-party bill payers) and to users.

The demonstration will last for 3 years, beginning December 15th. It is jointly funded by UMTA, Tri-Met, the City of Portland, social services agencies, and other state and local sources.

Project funding is shared as follows:

UMTA	$ 916,768
Tri-Met	510,000
City of Portland	240,000
Agency/Contracts	186,864
State/County/Other	35,634
TOTAL	$2,279,832

OBJECTIVES

The concepts established in this project relate primarily to the Service and Methods Demonstration Program objective of improving service for the transit-dependent population.

The principal project objective of Tri-Met, the project coordinator, is to improve the mobility of the handicapped and elderly by providing dial-a-bus and subscription services for those who cannot physically use the regular transit system. A secondary project operator objective is to assess the possible applicability of the automated fare recorder hardware for use in regular transit operation.

The major issues established by UMTA as the "cornerstones" of the project are:

- The feasibility of having a public transit agency operate a special transportation service,
- The performance, acceptability, and applicability of the automated fare recording and billing equipment, and
- The problems involved in coordinating a special transportation service, recognizing social service agencies' needs and their existing transportation activities.

Additionally, since the project's transit vehicle availability is limited, a set of priorities is being developed to insure that service can be provided to those most in need.

PROJECT DESCRIPTION

The project will provide special transportation services to the elderly and handicapped residents within Portland city limits. Preliminary eligibility criteria

Control Center Providing Dial-A-Bus and Subscription Service to Elderly and Handicapped Persons in Portland, Oregon

requires that these residents are unable to use regular transit for physical reasons and that, in addition, they are unable to afford alternative private modes.

The anticipated system design, being developed by Tri-Met and a transportation consulting firm, will provide for advance subscription scheduling for individual trips and planned group trips. Much, but not all of the service, will be provided under contracts with social service agencies. A system of scheduling is being developed that will provide service for trips which are (a) most needed and (b) can be incorporated into maximum productivity runs. There will also be a contractual relationship with Portland taxi operators to service those trips which cannot be supplied productively by the bus system.

Service will be provided by 15 16-passenger Mercedes-Benz diesel buses, each having two-way radio capability. Three of the buses will be outfitted to accommodate wheelchairs. Operating hours have yet to be established, nor has the fare structure been finalized.

A travel record will be generated each time a patron presents his identification card, containing vital billing information, to the driver. Thereafter, accounting will be handled by an automatic billing system which will debit social service agencies for the full trip cost. Optionally, costs per trip may be shared with Tri-Met depending on the funding limitations of a particular agency.

The City of Portland was selected as a site for a "second-round" demonstration of the special fare collection equipment because it is a medium-size American city with a transit operator interested in UMTA's project objectives. Additionally, Portland has no atypical features that would negate the transferability of the research findings.

Portland covers an area of 89.1 square miles and has a population of approximately 385,000, of whom 82,662 are disabled or elderly (65 years and over), according to U.S. Census statistics in 1970. Estimates of the number of persons in the following three target groups, based on surveys of pre-demonstration conditions are:

Wheelchair-Equipped Bus, Portland Handicapped and Elderly Transportation Project, Portland, Oregon

	Number of Persons	Percent of Population
Elderly, non-handicapped	39,500*	10.3
Elderly, "transportation-related" handicapped	16,500**	4.3
Non-elderly, "transportation-related" handicapped	4,600**	1.2

* 56,000 elderly (1970 Census) less elder handicapped cited below.
**Based on project survey conducted in spring, 1976, measuring pre-demonstration conditions (see Findings section).

The target population is now being served, to some extent, by Tri-Met, which operates over 400 buses on 49 routes in and around Portland. A city-supported non-profit program, Special Mobility Services, provides coordination of agency-owned vehicles offering limited service to the handicapped and elderly. City support for Special Mobility Services will be phased out when the demonstration system becomes operational.

HISTORY AND STATUS

The grant for the Portland Handicapped and Elderly Transportation Project was awarded on June 30, 1975. Planning began on September 1, 1975. Service will be implemented incrementally during the time period December 15, 1976 to February 15, 1977. It is expected that the project will be fully operational by February 15, 1977, and that the demonstration project will continue until September 1978.

Billings Requirement Survey

A review of potential social service agencies which could become third-party subscribers to the automated fare collection system was conducted in January 1976. Data needs of the social service agencies were determined to aid in specification of the automated fare collection procedures. Information about clientele transportation needs and agency transportation budgets was also gathered.

The five agencies reviewed required, as a minimum, itemized bills showing the number of trips and trip cost by day by agency-assigned client identification number, and the total monthly cost. In addition, destination points were needed for special accounting purposes. The agencies indicated that they would pay the full cost of trips for eligible persons.

It was found that some agencies could not use the service; others could transfer up to 90% of client trips to this type of service. Excluded trips were those which require medical aid enroute and those to destinations outside Portland's city limits. Otherwise, it is generally true that trips by the target population as well as some low income groups could be transferred to the project service. Most agencies estimated that their current transportation budgets could cover these trips.

The pre-demonstration survey, completed in April 1976, developed data on "existing" travel patterns of the targeted population and on their travel needs. This information will be the basis for the system design. Results of that survey are discussed under FINDINGS.

System design by Tri-Met and a transportation consulting firm has progressed to the point where certain design guidelines have been developed. These standards will be reviewed by various advisory groups and agencies and modified accordingly. The current standards are as follows:

- Average cost per ride to the agency sponsoring the trip should be $3.00, which is, in general, less than cabs or other private providers. (Individual users will pay a fare of $0.50 per ride for trips not sponsored by an agency.)

- Transportation services should be designed so that agencies in the community will find the special service relevant to their needs.

- Taxis, other providers, and regular Tri-Met service should be integrated with the demonstration program. This program should not result in elimination of satisfactory present programs or providers, but should supplement them.

- Handicapped and elderly should be utilized in the community advisory process and employed in the program.

- The systemwide 40% revenue-to-cost ratio should apply to this program.

- Reliability should be high, with the average difference between promised pickup and actual pickup less than 5 minutes.

- Utilization should be high; when the program is operational, 850 rides per day should be provided including 50 carried by taxicab.

- Customer confidence should be high; the system should generate not more than 2 formal complaints per day.

- Computerized billing should be employed; the system should be designed to minimize cost of operation while incorporating sufficient flexibility to meet the needs of every major agency.

Additionally, automatic fare collection equipment will not be available at the start of operations. A substitute manual system will be implemented initially with the automatic system introduced four or five months later.

FINDINGS

Characteristics of the Target Market

The pre-demonstration survey was conducted in April 1976 to develop information on the size of the target market (mobility impaired elderly and non-elderly and their travel needs). The procedure involved selecting a random set of households to be surveyed; approaching each house to inventory all residents by age; determining whether there were any handicapped persons living there (using a standardized, transit-oriented definition); and making arrangements to interview target individuals.

A functional rather than a medical definition of a debarring handicap was employed based on a set of eight activities which people are required to perform in using public transportation, i.e., can the individual:

a. Get on or off a public transit bus?

b. Walk more than 2 or 3 blocks?

c. Wait, standing, for more than ten minutes?

d. Keep balance while standing in a moving transit vehicle?

e. Move in crowds?

f. Read information signs?

g. Grasp coins, tickets, or handles?

h. Understand and follow transit directions?

Persons indicating they have a problem performing any of the above activities were designated as "transportation handicapped" and, therefore, interviewed. In addition, a fraction of the able-bodied elderly population and persons living in institutions who were not screened as handicapped were interviewed. During the interview, the interviewee was asked to respond to the eight activities in terms of whether each could be done "easily," "with some difficulty" or "could not be done at all." Based on these responses, the respondents were classified as able-bodied elderly (ABE), moderately transportation handicapped (MTH), or severely transportation handicapped (STH).

The survey method employed proved to be workable and efficient. Almost 6,000 houses and 27 institutions were approached; over 13,000 persons were screened; 777 were interviewed.

Incidence Rates

Using a functional definition of handicapped it was found that 5.5% of Portland citizens are transportationally handicapped (TH). This number is evenly divided between those who are severely handicapped (2.75%) and those who are moderately handicapped (2.75%). Handicap incidence increases dramatically by age, as shown in Table S-1.

TABLE S-1. INCIDENCE OF TRANSPORTATION HANDICAP BY AGE PORTLAND, OREGON

Age	MTH (%)	STH (%)
10-15	0.2	0.2
16-20	0.0*	1.0
21-59	0.6	1.3
60-64	3.0	3.2
65+	10.6	16.9

*Although no MTH were found in this age bracket, this implies the number is quite small.

Incidence of transportation handicap between males and females is generally comparable except in the over 65 bracket, where females exhibit a much higher incidence rate. Overall, the TH group is about 2/3 female and 2/3 elderly. In addition, 2/3 have household incomes under $5,000, and 1/3 are able to drive and have acces to an auto. One-fifth of the TH have full-time or part-time jobs.

Travel Habits

Able-bodied elderly persons make 1.4 one-way, non-walking trips per day, the moderately handicapped take 1.2 trips per day, and the severely handicapped take 0.8 trips per day. All members of the sample have trip rates lower than the national average, 2.2 trips per person per day.

Most of the trips made by the able-bodied elderly and transportation handicapped groups are to shopping, social, and recreation activities. The automobile is used for over 75% of all trips. Severely handicapped persons are the largest taxi users, in spite of their generally lower incomes. About 20% of the moderately handicapped and 10% of the severely handicapped say they use the present bus service. Of those interviewed, there is also a disproportionate use of the bus by lower income persons.

As shown in Table S-2, almost all able-bodied elderly and about 85% of the moderately handicapped say they can use the present Portland fixed route bus service, but only 30% of the severely handicapped can. The percentage who say they could use the bus is raised to about 50% if special features are added to the bus design (i.e., lower steps, more handrails, reserved seats), and an additional 25% could use the service if the bus makes door-to-door deliveries.

If both changes are made simultaneously, about 90% responded that they would be able to use the bus system.

TABLE S-2. ABILITY TO USE MODE BY HANDICAP CLASSIFICATION

	ABE (%)	MTH (%)	STH (%)	ALL TH (%)
Fixed Route Regular Bus	97.5	87.3	31.1	59.2
Fixed Route Special Bus	97.8	93.5	52.4	73.0
Fixed Route Bus with Ramp	97.0	90.2	51.6	70.9
Door-to-Door Regular Bus	98.9	97.9	73.7	85.5
Door-to-Door Taxi	98.9	99.5	91.4	95.4
Door-to-Door Bus with Ramp	97.7	97.8	90.8	94.3

Thus, the key to improving service for the transportation handicapped appears to be door-to-door service; fixed route service is a problem for many regardless of additional features, including lifts/ramps. Taxi service appears to be as acceptable as a door-to-door bus which has special features, including a ramp or lift for wheelchairs. The useability of lifts/ramps depends on the addition of special features within the bus as well, e.g., wider aisles.

Trip Patterns vs. Time

Almost half of all sample trips are repeated weekly or more often with no significant difference in trip-making regularity found among the able-bodied or transportation handicapped classifications.

Frequency of Trip	%
Daily - 5 to 7 times per week	11.4
Frequently - 2 to 4 times per week	19.4
Weekly - once a week	16.2
Occasionally - less than once per week	53.0

Trips were scattered fairly evenly among the days of the week with 13-18% of trips falling on any one day except for Friday and Saturday which accounted for 8.4% and 11.6% of the trips, respectively. Finally, 27.3% of the trips are repeated at the same time of day, e.g., church and regularly scheduled activities.

About half of the reported trips are less than ten minutes in length. The origin/destination patterns of these trips (recorded in terms of 17 traffic zones) are such that most trips are within sectors of the city, suggesting a zonal, demand-responsive service might be effective.

Wheelchair/Walker Users

About 12% of the handicapped group use wheelchairs or walkers (W/W), implying that they need a level-entry vehicle and are unable to use standard buses. They are generally quite similar to all severely transportation handicapped (STH) in sex, age (they are slightly younger), income, auto availability and employment status (see Table S-3). Only 16.7% of this group possess a driver's license. Their trip-making rate is 0.5 per day, significantly lower than the severely transportation handicapped figure of 0.8 trips per day.

Table S-3 compares transportation modes of the severely handicapped and wheelchair/walker group.

Table S-3. PERCENT OF STH TRIPS MADE BY TRANSPORTATION MODES

	STH	W/W
Auto Driver	33.0	24.6
Auto Passenger-Relative	36.7	23.1
Auto Passenger-Friend	10.9	30.8
Auto Passenger-Agency	3.3	4.6
Regular Bus	10.5	1.5
Taxi	2.9	4.6
School Bus	0.0	0.0
Other	2.5	10.7

IMPLICATIONS

Because of the current national concern for the mobility of elderly and handicapped persons and current Federal law and regulations which require regional and local planning to assure this mobility, it is important to understand the transferability of the Portland findings to other areas. At this time, little is known concerning how elderly and handicapped mobility rates and patterns vary between regions.

The transportationally handicapped incidence of 5.5% measured in this survey reflects specific characteristics of Portland. The figure will be higher or lower in other urban areas depending primarily on two factors--the elderly incidence and the work disabled incidence, as recorded in census data. The Census statistics for several selected cities are:

SMSA	% > 65	% disabled (16-64)
New York	10.5	5.3
Chicago	8.5	5.2
San Francisco-Oakland	9.1	5.9
Miami	13.4	6.6
Portland	10.2	6.2

Thus, a given area might expect its transportation handicapped incidence to be higher or lower than Portland based on its values of these two demographic measures.

In addition, the distribution of health problems, use of health aids, and many of the demographic variables from the Portland survey can probably be used in other areas for planning purposes. These distributions may vary somewhat with the elderly incidence.

APPENDIX T

CHICAGO SPECIAL TRANSIT SERVICE PROJECT FOR THE MOBILITY-LIMITED

PROJECT OVERVIEW

The Chicago Special Transit Service Project for the Mobility-Limited is an experimental Service and Methods Demonstration project. Its purpose is to demonstrate the planning and operation of a demand-responsive transit service for the mobility limited, i.e., handicapped persons, in a major metropolitan area. The project will seek to determine the most effective and efficient combination of this service and the existing, conventional fixed-route system.

This project is planned as a "big city" test of the provision of special demand-responsive transportation services to handicapped and elderly persons. The city is investigating approaches to provide this service that are politically and technically feasible within Chicago and which meet the UMTA final regulations on transit accessibility. Thus, it is a "big city" version of a similar project being implemented in a medium-size city (Portland) and operational demonstrations in small town areas (Danville, Illinois, and Naugatuck Valley, Connecticut).

The project is currently in a planning phase, wherein the City of Chicago, the Chicago Transit Authority (CTA), and various social agencies are developing the required system. A second phase of the demonstration will then be proposed to UMTA in the spring of 1977, to demonstrate the system in operation.

Planning for this experimental project began in July 1975. The planning phase is funded jointly by UMTA, Chicago Department of Public Works, the Mayor's Office for Senior Citizens and CTA. Funding is shared as follows:

UMTA (IL-06-0033)	$60,765
Chicago Department of Public Works	6,228
Chicago Mayor's Office for Senior Citizens	456
CTA	8,507
TOTAL	$75,956

PROJECT OBJECTIVES

The project directly addresses two of the five SMD program objectives: improving transit coverage, and improving service for the transit-dependent. Less directly, in experimenting with operational problems of the demand-responsive service, the project will also address the remaining three SMD program objectives: reducing travel time for transit users, improving the reliability of transit service, and increasing transit vehicle productivity.

The City of Chicago has defined four objectives for the demonstration as follows:

- Define the relationship between special demand-responsive service and conventional transit service in a major metropolitan area. Chicago already has extensive conventional transit service. The new service may play a role ranging from a completely separate and parallel service, to a feeder service to selected rapid rail stations.

- Determine the ability of demand-responsive service to meet the transportation needs of the mobility-limited. The demand-responsive service will be designed to overcome the limitations of conventional transit for the mobility limited by being flexibly routed, by offering door-to-door service, and by generally minimizing the travel barriers facing the handicapped.

- Determine the effectiveness of a mechanism to coordinate area-transportation services for the mobility-limited. The new service will complement many existing services offered by private companies and social services. A clearinghouse for information on all transportation services for the handicapped will be established to promote greater service efficiency and, hopefully, to serve as a

first step in coordinating service standards, fares, routes, schedules, etc., in order to improve vehicle productivity.

- Determine the potential of demand-responsive service for wider application. In light of recent UMTA regulations, the service will be evaluated as a means of providing greater mobility throughout the urban area for those with special transportation disadvantages.

Key project issues to be examined in this planning phase are:

- <u>Relationship of Demonstration Project to UMTA Regulations</u> -- The major issue is how the City of Chicago will relate the demonstration project to some large pattern of activities that will bring them into compliance with the final UMTA regulations on transportation for elderly and handicapped persons.

- <u>Definition of Mobility Limited</u> -- The issue is whether the definition of the mobility limited will be limited to the most severely handicapped persons and, if so, the political ramifications of isolating service to selected portions of the handicapped population. Related to this is the working out of certification processes that are consistent with this definition and yet practical and equitable.

- <u>Role of CTA in Demonstration Project</u> -- The role of the CTA in the demonstration project has not yet been determined, that is, whether they will act as the carrier or will defer this role to social agencies or private operators.

- <u>Use of City-Wide Survey of Handicapped</u> -- A city-wide survey of the needs of transportationally-handicapped persons is in progress. A procedure has been worked out to use this survey to document the "before" conditions of the demonstration. However, there remain uncertainties and shortcomings concerning sufficient sample size in the demonstration area and the need to isolate an adequate control group for the project.

- <u>Feasibility of Coordination Function</u> -- The demonstration project staff will determine whether the coordination of transportation services, called for in the third objective, is politically feasible.

PROJECT DESCRIPTION

The project service is envisioned as demand-responsive, using up to 20 buses serving mobility-limited people in a sector of Chicago. A mobility-limited person has been tentatively defined, for the purposes of this project, as "anyone who, by reason of illness, injury, age, congenital malfunction, or other permanent or temporary incapacity or disability, is restricted or otherwise limited in their ability to utilize mass transportation facilities and services."[1] During the planning phase of the project, this definition is expected to be refined to provide the most appropriate eligibility criteria for prospective users of the special-transit service. This is necessary in order to restrict the service to those who truly need it, to ensure that people capable of using the existing transit system will not be drawn away from it, and to define a market whose size is appropriate to the scale of the planned service.

The project service area will be defined within a general-target area in the northeast part of Chicago. This district is shown in Figure T-1. It is bounded by Lake Michigan on the east, the Chicago city limits on the north, the Chicago River on the west, and North Avenue on the south. There are 532,450 people living in the area, including a substantial portion of the city's elderly and, it is believed, handicapped populations. It is estimated that 13,600 mobility-limited elderly live in this part of the city--the number of other mobility-limited people is not known. The minority group population is approximately 10%.

Land use is predominantly residential, of a wide variety of types and conditions. Densities are generally high (27 dwelling units/acre), declining with greater distance from the lake. The area is well-served by retailing and commercial facilities. There is substantial industrial development along the Chicago River. There are parks along the lakefront and extensive public transportation service to the central business district.

The service area was selected because it is a low income area with a high concentration of elderly and handicapped persons in an appropriate size sector of Chicago. In addition, the area has an internal flow of

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[1]U.S. Department of Transportation, The Handicapped and Elderly Market for Urban Mass Transit, October 1973, pp. 2.

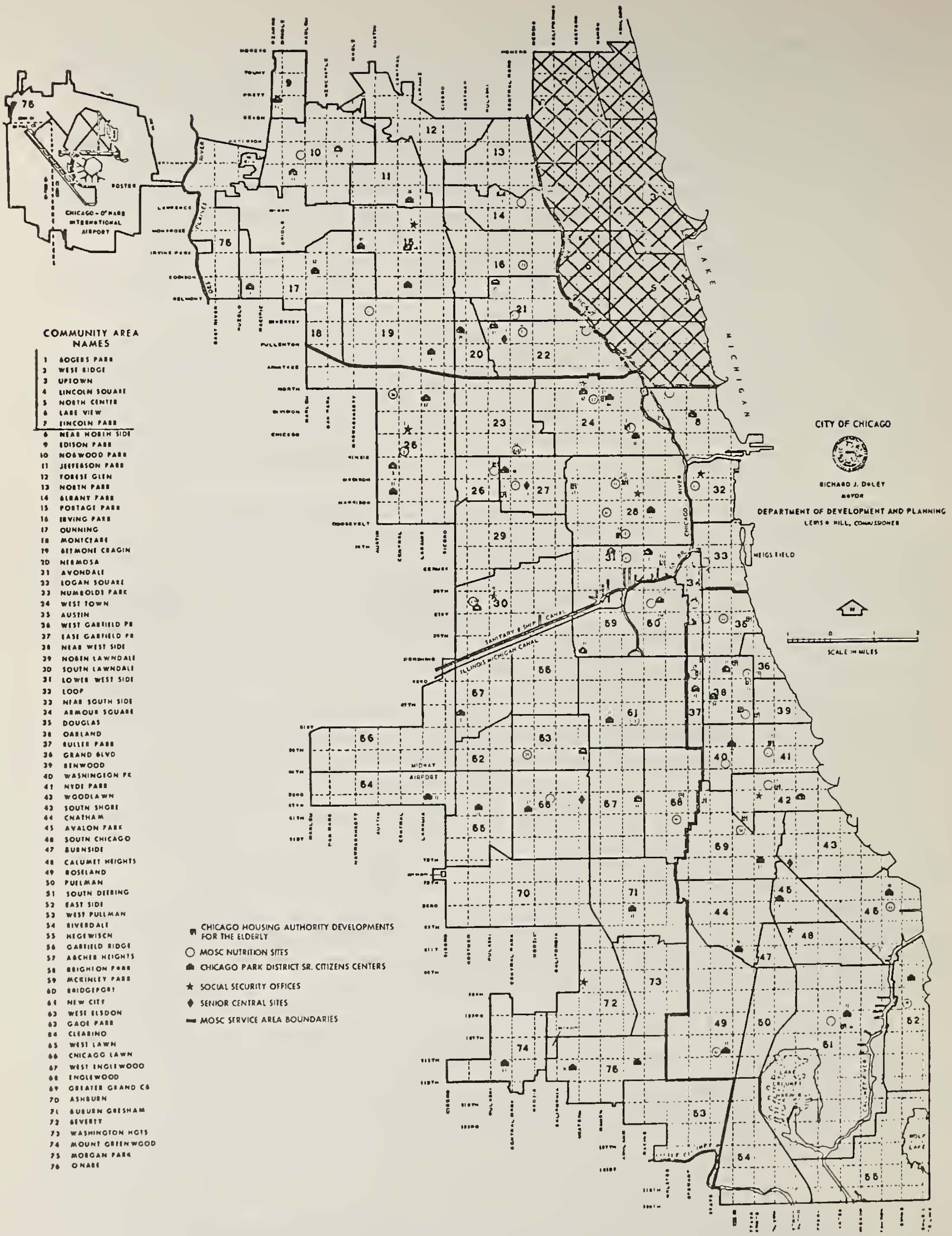

FIGURE T-1. CHICAGO PROJECT SERVICE AREA

travel that would lend itself to a zonal demand-responsive system.

The test area is served by an excellent system of bus routes in addition to two rapid transit lines. It has not yet been determined if the special service in this area will be a separate, parallel system or a feeder service to selected rapid transit stations.

There are also a variety of special transportation services provided by social agencies for their various clients. One of these services, operated by the Mayor's Office for Senior Citizens (MOSC), is essentially the forerunner to this project system. MOSC now has $150,000 from the city to operate a city-wide service for severely handicapped people. MOSC will be replaced by or will be working as a coordinated complementary system to the Chicago Special Service Project for the Mobility-Limited.

PROJECT HISTORY AND STATUS

The project is envisioned to consist of three phases, estimated to required at least 33 months. These phases are:

Phase I: System Design -- The travel needs of the mobility-limited and the most effective approach to meeting them is to be determined.

Phase II: System Development -- This is an implementation phase in which the project participants will review the results of Phase I and prepare for the operational phase. Also, an administrative structure will be established for coordinating other transportation services for the mobility-limited.

Phase III: System Operation -- Vehicles will be on the road delivering service. The City will continuously monitor the service and experiment with changes in services, fares, and other operational features. Data will be collected for the final evaluation phase.

A grant application for planning was first made in April 1973. A second application was made in March 1975 for $60,765; work began in July 1975 on Phase I.

A detailed work plan for Phase I has been established, and the system design is being prepared according to that plan. The operational details, including selection of a transit operator, have not been formulated. In order to

further define the area to be served, the certification system to be used, and the initial nature of the service, project participants are assembling data on mobility needs in the project area. The available published data have been reviewed. Additional data will probably come from a separately funded city-wide survey of the transportation needs of the mobility-limited. Administrative problems, personnel changes in CTA, and technical delays in performing the pre-demonstration survey have delayed work on Phase I. Completion of a grant application for Phases II and III is not expected until May 1977.

Further information is being compiled with a survey of existing providers of transportation services to the elderly and handicapped of Chicago. Once analyses of this survey are complete, a consortium of agencies will be created to provide service to the target groups. It is also the City of Chicago's hope that a conference on transportation for the elderly and handicapped will be held with representatives from existing providers, the city, CTA, UMTA, and HEW.

One effort related to the coordination element (Phase II) has been completed. In order to make more widely available information about special services which already exist within the city, a Directory of Transportation Services for Handicapped and Elderly has been developed. This bold print document is designed for ease of use and contains an inventory of over sixty-nine current providers of specialized transportation in the City of Chicago. Four categories of providers are listed: social and general service organizations; special health organizations; bus, limousine and livery companies; and paramedics. Under each provider is information concerning eligible clients, including necessary physical considerations, area compatibility, membership requirements, service type and service policy, and types of vehicles.

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